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# Why Economic Growth Stimulates More Growth in Some Countries Rather than Others

ABSTRACT Leontief multipliers are an important component of economic growth. However, input–output analysis is generally treated as a methodological tool for studying other questions in development. The size of multipliers themselves is of interest, as they determine how much nations benefit economically from the growth of base industries. Of the three types of multipliers—industrial supply purchases by firms, consumer goods purchases by workers, and growth derived from all sources—only the first has attracted attention in the global value chain literature; the other two have been neglected. We use OECD data on a large sample of nations in 2005, 2010, and 2015 to show that significant cross-national and inter-industrial differences exist in the size of multipliers. Contrary to expectations, higher-income countries can sometimes have lower multipliers than lower-income countries. The largest multipliers tend to be in the global South. We then provide a model explaining the differences in multipliers in terms of the domesticity of purchases, the wage intensity of production, the geographical size of the country, and the changing roles of GDP per capita and education as societies develop. The significance of these findings for development policy is discussed. KEYWORDS Development, Growth, Leontief multipliers, Import substitution, Wages

Leontief multipliers are measures of how increases in the production of any one industry affect the rest of the economy. The data used for the calculation of GNP also list the buyer–seller transactions in the economy. These data can be used to estimate, for any given nation and industry, how much an increase in production in that sector increases purchases from suppliers, wages paid, and the consumer purchases made with those wages. These secondary effects are essential components of economic growth that merit scholarly attention in their own right.

It is undoubtedly important for developing nations to develop new base industries. Victorian Britain certainly benefited from the rise of factory textiles. Contemporary India

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is benefitting from the rise of the software industry. However, looking only at those base industries ignores the their secondary effects on purchases from suppliers and purchases of consumer goods by newly employed workers. This omission becomes particularly serious if economies vary in the size of their multipliers. If Indonesian agriculture were to have higher multipliers than Malaysian agriculture, say, that would have enormous implications for the importance of agriculture in both countries.

Unfortunately, such omissions are the rule rather than the exception in development sociology. As the literature review below suggests, most sociological work on development concentrates on core transformative industries per se. And there is a special emphasis on industries with significant technological advantages that allow the nations with such sectors to become dominant in global trade. Such accounts pay particular attention to nineteenth-century British textiles and railways, German and American steel, mid-twentieth-century American auto manufacture, and the late-twentieth-century computer and software industries. The dominant success stories are those of England, Germany, the United States, and Japan.

Development sociology has done little to explain the rise to wealth of the rest of the global North. What high-tech export domination was associated with Australia, whose primary export was wool? Or Canada, whose primary export was grain? Growth in many countries in the global North came from sales within those countries of routine articles such as housing supplies, food, clothing, or cement. A multiplier-based approach reorients the study of development to those routine industries that make up much of the activity associated with economic growth. It reorients development sociology to an understanding of variance in the growth capacity of mundane non-export industries rather than focusing inappropriately on a small number of glamourous cases. Nations vary in their ability to create growth in these more routine sectors. Development sociologists need to be able to explain this variance.

The strategy of exposition in this paper will be somewhat unusual. Traditionally, sociology papers present theory first, then methods, and then use data to test the theory. In this case, the dependent variables, the three types of Leontief multipliers, are unfamiliar to most readers and have received little attention in the discipline. And the pattern of empirical variations associated with these variables is equally unfamiliar. So we begin with an explanation of Leontief multipliers, including the three different types and why they matter. We follow with a series of maps showing the global distribution of Leontief multipliers by size. We expect most development sociologists will find these patterns surprising. We then present a theoretical discussion of the determinants of multiplier size, followed by statistical tests of our explanatory hypotheses. Multipliers are a function of the wage intensity of production, the domesticity of production, and the country's physical size (rather than population). Levels of development and education also matter but in a more secondary and inconsistent manner.

## THE THREE KINDS OF LEONTIEF MULTIPLIERS

Leontief multipliers are calculated from the same data used to calculate GDP. The data on what firms produce also include where the output goes. So all economic transactions in an economy can be clustered into buyer–seller pairs. Such data allow the calculation of the following measures:

- The volume of production of any industry.
- For each unit of production in an industry, the quantity of supplies that are purchased to produce that output.
- For each unit of production in an industry, the quantity of labor that is purchased to produce that output.

Purchases of goods by consumers are also listed in the GDP data. Thus, it is possible to calculate

- For each unit of production in an industry, the quantity of consumer goods that workers purchase with the wage payments received in that industry.

Leontief multipliers are summary statistics of these measures. Using the terminology of Miller and Blair (2009), in this paper, we discuss:

*Type II or total multipliers*: The supplemental economic growth that comes from growth in a base industry that is derived from all sources.

*Type I or industrial supply multipliers*: The supplemental economic growth that comes from growth in a base industry that is derived narrowly from that industry's purchase of production inputs.

*Type II–I or worker consumption multipliers*: The supplemental economic growth that comes from growth in a base industry that is derived narrowly from the wages that are paid to workers in the base industry and the purchases of consumer goods that are the results of those wages.

## MULTIPLIER ANALYSIS IN DEVELOPMENT SOCIOLOGY AND DEVELOPMENT ECONOMICS

Development sociology has often ignored multipliers. Most sociological writing has been about base industries—often industries believed to be transformative for an economy. Midcentury modernization theorists focused on the textile factories of the British Industrial Revolution (Smelser 1959), the American automobile industry (Blauner 1964), or factory work generically (Hoselitz 1963; Moore 1963). These transformative industries received disproportionate attention because such sectors dramatically increased national income and transformed social and class relations, leading to essentially modern forms of social organization. Secondary growth external to the transformative industry was viewed as epiphenomenal—a semiautomatic byproduct of macro-level societal changes.

An emphasis on transformative sectors also characterized the developmentalist state literature (Amsden 2001; Evans 1979; Wade 1990). Here, the focus was on constructing one or more key industries that could produce excellence in exports and reverse preexisting dependency in global trade. Objects of analysis included petrochemicals, textile manufacturing, ferrous metals, and shipbuilding. Other sectors, such as agriculture, were considered only insofar as they supported the key export industry, typically by providing subsidized inputs such as food or energy. Subsidiary sectors were rarely considered a source of growth themselves.

Classical dependency theory paid more attention to multiplier effects. Latin American structuralists explained the low impact of foreign investment on growth in the periphery in terms of disarticulation. Cardoso and Faletto (1979) argued that underdevelopment was due in part to the presence of *enclave industries*, industries that purchased all of their inputs from abroad and employed few workers. Even though these workers were relatively well paid, there were too few of them to either eliminate poverty or generate secondary demand through worker purchases. Disarticulation thus invokes the importance of both Type I (supply) and Type II–I (consumption) multipliers. Extensions of this argument to Latin American economies as a whole can be found in the writings of such *dependistas* as Amin (1976), de Janvry (1981), and Elsenhans (1984).

Type I multipliers are also implicitly invoked by advocates of import substitution and in the literature on global commodity chains. Import substitution writers (List 1966; Prebitsch 1950; Reinert 2007) wish to see all manufacturing done locally. Thus they don't devote extensive attention to what industries produce the most purchases locally—a significant omission. However, they are sympathetic to the concept of developing backward linkages.

Within contemporary development sociology, the global value chain literature uses Leontiefian logic extensively (Bair and Gereffi 2001; Gereffi 1999; Kaplinsky 2000; Morris, Kaplinsky, and Kaplan 2003). This literature pays very explicit attention to the problem of the domestic sourcing of industrial inputs as an independent source of economic growth. The treatment of Type I (supply) multipliers in this literature is sophisticated and helpful. There is almost no discussion of Type II–I (worker consumption) multipliers.

In this article we explicitly follow the tradition of social democratic theorists writing about the global North. Authors such as Sydney and Beatrice Webb (1897), Wolfgang Streeck (1994), and Joseph Stiglitz (2013) emphasize the importance of wages and consumption in economic growth. Social democratic theorists argue that high wages and employment are themselves a cause of further economic growth through consumer spending by workers. Late-generation underdevelopment theorists and more contemporary critics of globalization and financialization have made similar arguments for the global South (Stiglitz 2003; Sunkel 1993). Understanding the impact of base industries on further economic growth requires explicit consideration of the number of workers hired, the wages they are paid, and the subsequent effect of Type II–I multipliers on growth.

Development economics has shown little interest in the relative size of Leontief multipliers, with some exceptions. Typically, input–output matrices are used as a methodological tool to assess the effect of possible policy changes on economic growth. Wassily Leontief's *Input-Output Economics* (1986) is typical of this tradition. It analyzes the effects of increasing imports, international arms trading, population, and wages on economic growth at the national level. Analyses of the effects of trade openness on growth are common (O'Connor and Henry 1975; Ohno 1988; Thomas-Bulmer 1982). Advocates for particular industries sometimes use input–output analysis to show the centrality of their sector to the larger national economy (Bhardwaj and Chadha 1991; Bon and Pietroforte 1990; Haggblade, Hazell, and Dorosh 2007). Because input–output analysis is a powerful tool, these studies are generally convincing on their own terms.

## DATA SOURCES FOR LEONTIEF MULTIPLIERS

The OECD maintains a database of harmonized input–output tables that remains one of the most comprehensive available for public use (https://stats.oecd.org/Index.aspx?DataSetCode=IOTS_2021). These matrices provide data for all member nations and several nonmember economies. The data are presented using an industry-by-industry approach to allow "better integration with collections of statistics compiled according to industrial activity such as R&D expenditure, employment, foreign direct investment, and energy consumption" (OECD, n.d.). The tables are "matrices of inter-industrial flows of goods and services produced domestically and imported in current prices (USD million), for all OECD countries and several non-member economies (including all G20 countries), covering the years 1995 to 2018" (OECD, n.d.). The breadth of the OECD data supports a complete picture of the national economies and the inter-industrial compositions of a broad sample of nations.

The original OECD input–output tables cover 36 different industrial categories. Because our approach focuses more on national differences, we aggregate these into 11 broad categories, the 11th being households.[1] Furthermore, we analyze input–output matrices only for the years 2005, 2010, and 2015, given that multipliers tend to change slowly over time. Our final sample includes 61 nations.

The calculation of input–output matrices requires high-quality data on all economic transactions that occur within an economy. Input–output data are the same data used in the calculation of GDP statistics, and are subject to all of the well-known limitations concerning the accuracy of the measurement of GDP. Data are likely to be inadequate in countries with a large informal sector or weak or inefficient governance, or that are undergoing civil wars or regional instability and unrest. Informal transactions are, by definition, unreported to state agencies. Weak or fragile states may lack the bureaucratic capacity to collect data in frontier areas, rural areas, the slum areas of large cities, or even formal establishments in easily accessible cities. As a result, there are severe methodological questions about the accuracy of GDP data in the low-income countries that experience many of these characteristics (Jerven 2013; Morgenstern 1965). Factors that potentially contaminate GDP data pose far more significant challenges to the validity of Leontief data, which requires very fine-grained analyses of economic transactions. Thus our sample consists mainly of high- and middle-income nations.

For the mathematical details of how Leontief multipliers are calculated, see the appendix.

## DESCRIPTIVE FINDINGS

To evaluate the cross-national differences in multipliers, we present a series of comparative choropleth maps of multiplier size. These maps are based on the weighted average multiplier of all industries for each of the 61 countries in our sample. For the maps of Type I multipliers, the average is based on the 10 industrial categories, excluding households. The averages for the Type II and Type II–I maps are based on all 11 industry categories, including households. For simplicity, we provide maps only of the 2015 data, as the cross-national differences and patterns for 2005 and 2010 are essentially similar.

We find substantial differences between cross-national multipliers. Figure 1 shows a global map comparing the total multiplier (Type II) sizes of the 61 nations in our sample. The countries with the highest total multipliers are not particularly rich nations.

Argentina and Brazil have the highest Type II multipliers, followed by Australia and the Philippines. Meanwhile, the United States, one of the wealthiest countries in the world, has a multiplier similar to that of lower-income countries such as India, South Africa, and Peru. This empirical distribution of high and low multipliers invalidates the theory that higher-income countries generally have higher multipliers than do lower-income countries.

Europe does not have distinct Type II multiplier size patterns. No European country has a very high Type II multiplier, but France, Spain, Italy, and Romania have somewhat higher-than-average multipliers. Great Britain, Germany, Sweden, and Finland have average total multipliers. Norway, Switzerland, Denmark, and the Benelux countries have low total multipliers. For this sample, the Benelux countries, Malta, Brunei, Singapore, and Ireland have the lowest multipliers.

While there is no evidence of a higher income–higher multiplier or lower income–lower multiplier effect, countries with a larger land mass tend to have higher Type II multipliers than smaller countries. Argentina, Brazil, Australia, China, and the US are all large nations with high multipliers. And many small countries, such as Singapore, Ireland, and the Benelux countries, have some of the lowest multipliers in the sample.

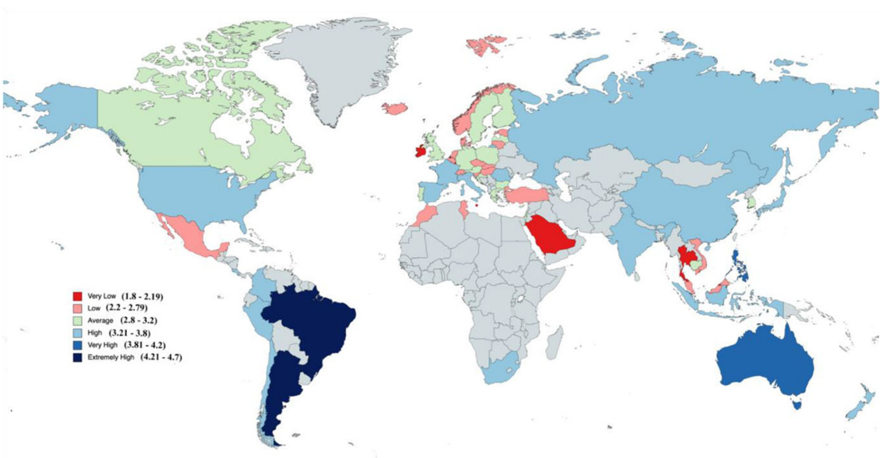


FIGURE 1. Total multipliers (Type II) in 2015.

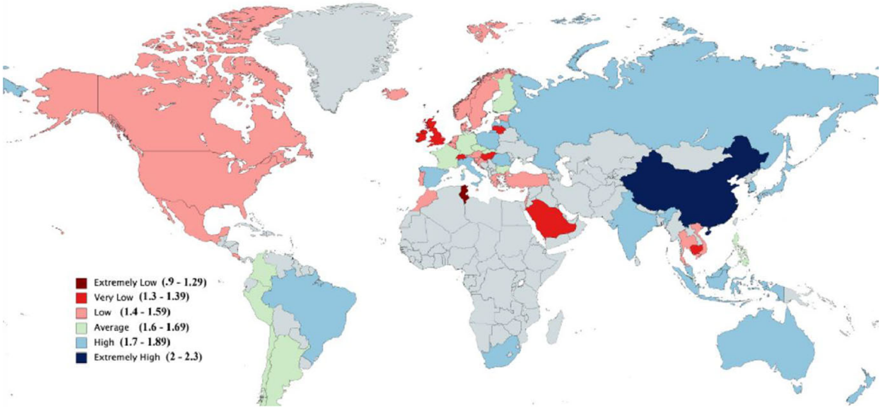


FIGURE 2. Industrial supply multipliers (Type I) in 2015.

Figure 2 shows a map comparing the industrial supply multiplier (Type I) sizes for the nations in our sample.

China has an extremely high industrial supply multiplier. China supplies industrial inputs to much of the world. Thus it is not surprising that China also provides the bulk of its own needs for industrial supplies. In contrast, the United States and Canada have low industrial supply multipliers. In comparison to the rest of the sample, these suggest that wealth and technological capacity do not always translate into a higher Type I multiplier.

Europe is divided in its industrial supply multipliers in ways without obvious explanations. Spain and Poland have high industrial supply multipliers; Britain, Switzerland, Hungary, and Lithuania have extremely low multipliers. Southeast Asia has low industrial supply multipliers, while Indonesia and Australia have high multipliers. Latin America also has a diverse range of Type I multipliers.

Figure 3 maps worker consumption multiplier (Type II–I) sizes for the nations in our sample.

The map features a pattern similar to the Type II map's large land area–high multiplier and small land area–low multiplier landscape. Large nations such as the United States, Russia, Brazil, and Australia have high multipliers, while multipliers are particularly low in Singapore, Luxembourg, Brunei, and Malta. Europe also again has a large range of multiplier sizes, evading easy explanations.

Surprisingly, Argentina, Brazil, and the Philippines have the highest worker consumption multipliers. While each of these countries has somewhat strong unions and relatively favorable labor laws, none of them have the highly pro-worker labor regimes of such highly unionized settings as Scandinavia and Germany. Argentina, Brazil, and the Philippines are known for large informal sectors, high levels of disarticulation, high levels of worker poverty, and substantial worker exploitation. The United States has a higher worker consumption multiplier than Canada despite Canada's more favorable labor legislation. With its very strong worker protection, Switzerland has a low Type II–I multiplier.

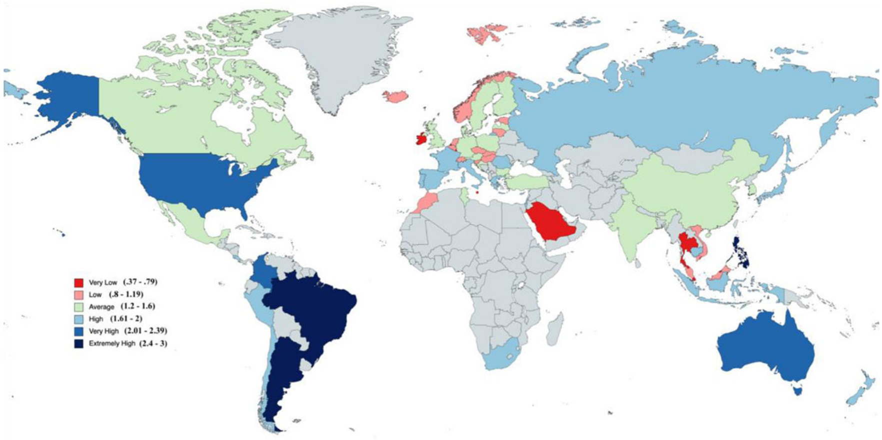


FIGURE 3. Worker consumption multipliers (Type II–I) in 2015.

Overall, Europe again has a large range of multipliers, evading easy explanation. Russia, most of Southern Europe, and Iberia have high multipliers. Northern Europe is mostly average. The Benelux countries, Austria, Slovakia, and Hungary have low Type II–I multipliers.

The differences we report here are substantively large. They are particularly striking for Type II–I multipliers. If we compare minimum versus maximum cases in 2015, Argentina got 45% more total multiplied GDP growth from an increase in base GDP than Ireland did. China got 76% more industrial supply growth from an increase in base GDP than Tunisia did. What is particularly impressive is that Argentina got 471% more growth in worker consumption from an increase in base GDP than Brunei did. These conclusions persist in whole-sample analyses that do not emphasize extremes. Generally, differences in Type I multipliers are relatively small; the standard deviation is only 0.17. This is ironic given the emphasis of the global commodity chain literature on increasing Type I multipliers in low-income nations. Type II and Type II–I multipliers have far larger standard deviations, at 0.58 and 0.50, respectively. Raising a multiplier from 2 to 2.5 would represent a dramatic acceleration of growth rates.

## DETERMINANTS OF MULTIPLIERS

We present here a model of multiplier size that emphasizes the domesticity of production, the wage intensity of production, and the physical size (area) of the national economy. These arguments are drawn from the import substitution literature, the social democratic literature, and a less well-known input–output scholar. Because the dependency literature heavily emphasizes levels of socioeconomic development as well, we include that as a control.

*Domesticity of supply/consumption.* One of the reasons China has a high industrial supply multiplier, and the United States does not, is that both countries obtain their industrial supplies from China. Following import substitution writers such as those of the

CEPAL school, we argue that producing inputs locally rather than through imports will increase multipliers. Producing industrial goods locally will increase Type I (industrial supply) multipliers. Producing consumer goods locally will increase Type II–I (worker consumption) multipliers. In principle, either could increase Type II (total) multipliers, although in practice we find domesticity of consumer goods has a slightly greater effect. Note that the global value chain literature makes similar arguments, emphasizing that the transition from foreign to local supply in commodity production promotes economic growth in the global South. The dependency literature's critique of enclave economies parallels this argument in claiming that enclaves obtain all of their inputs from foreign sources. Within the input–output literature, Kubo (1985) has suggested domesticity of intermediate inputs as a key determinant of multiplier size. We measure domesticity of industrial supply and domesticity of production of consumption goods from data in the Leontief input–output matrices. Those matrices list, for all economic transactions, the percentage involving imported goods or services. We use the domesticity of household purchases, otherwise called household domesticity, for Type II–I multiplier analyses, and the domesticity of industrial purchases, otherwise called industrial domesticity, for Type I multiplier analyses.

*Wage intensity.* Social democratic theorists argue that economies grow through high employment and high wages increasing Keynesian demand. It stands to reason that such factors would increase multipliers as well. The *dependista* critique of enclave economies parallels this argument by maintaining that enclaves hire too few workers to significantly impact the local economy. (Enclave economies do, however, pay those workers relatively high wages.) What matters is both the wages paid to workers and the labor intensity of production. We call this joint factor *wage intensity*. A disarticulated economy that uses capital-intensive production technologies will not be wage intense, even if remuneration for individual workers is high. An economy with high labor force participation and employment rates could be wage intense regardless of wage rates—although high wages also help. For our study, the wage intensity data come directly from the input–output matrices. The matrices provide data on the total wages spent by the industry in relation to its total production. In short, wage intensity is how much a nation spends on wages relative to the size of its economy.

Although wage intensity is likely to increase worker consumption multipliers, it will also likely decrease industrial supply multipliers. Type I multipliers depend on the amount of material firms purchase. Industrial supplies, whether raw materials, machinery, or even money per se, are all basically forms of capital. Since capital-intensive technology increases the use of material inputs, we would expect wage intensity to be inversely related to industrial supply multipliers.

*Area.* A striking pattern in the data is that large countries tend to have higher multipliers than small countries. Argentina, Brazil, Australia, China, and the United States are all large nations and have overall larger multipliers. And many small countries, such as Singapore, Malta, and Brunei, have small multipliers. Shishido et al. (2000) argue that geographical size largely influences the transportation multiplier for large countries. Goods must be transported farther within a large country than in a small country. Now, to be sure, goods may travel the same distance in regions with small countries, such as Europe, as in regions with large countries, such as South America. However, in Europe, more of that travel will be outside the borders of the consuming nation. Take French wine sold in Denmark, which will have traveled through France, Germany, and Denmark. A similarly long producer-to-market trip for a Brazilian firm would take place entirely in Brazil. In the European case, the truck driver could be French, German, or Danish. The truck driver in Brazil would almost certainly be Brazilian. The increase in the transportation multiplier has linkage effects that raise multipliers for industries that provide inputs to transportation and the national multipliers as a whole. For this analysis, the area data are from the World Bank (2022).[2]

*Socioeconomic development indicators.* We de-emphasize the role of socioeconomic development in the prediction of multipliers—we maintain that the roles of domesticity, wage intensity, and area are more fundamental. The maps presented above showed no particular tendency for rich nations to have higher multipliers. Socioeconomic variables are not irrelevant, but their effect is both weak and complex. The simplest argument is to claim that high socioeconomic development is correlated with high multipliers. Modernization theories, dependency theories, and developmental state theories all argue that rich nations have a greater technological capacity, which gives them a global competitive advantage in manufacturing (Barro 1991; Pastor et al. 2018; Szirmai and Verspagen 2015). Global commodity chain theorists are particularly emphatic on this point (Kaplinsky 2000; Morris, Kaplinsky, and Kaplan 2003).

We believe this simple logic is only partially correct. It applies in full force to Type I industrial supply multipliers for all the reasons listed above. But Type II–I (worker consumption) multipliers have a different dynamic. Their size is determined by the share of the consumption of basic goods and services in the national economic activity. Consumption represents a smaller component of wealthy economies than it does of poorer economies. Macroeconomic theory argues, in our view compellingly, that poor individuals have a higher propensity to consume while wealthy individuals have a higher propensity to save (Keynes 1936; Wonnacott 1984:58–62). Poor people have basic consumption needs that are nondeferrable, such as food, housing, and medical care. Wealthier individuals have these needs covered and can afford to invest and save for the future. Kuznets (1962) found a strong negative empirical correlation between per capita GDP and the share of private consumption in the economy. Wealthier countries had larger rates of capital formation and larger shares of government expenditure. All of these would reduce the impact of increasing private consumption on overall economic activity and give wealthier societies smaller Type II–I multipliers.

We use GDP per capita and educational attainment as measures of socioeconomic development and technological capacity, respectively. The data are from the World Bank.

## INDUSTRY-NATION-YEAR DATASET STRUCTURE AND STATISTICAL METHODS

Our data consist of multipliers for 61 high- and middle-income nations for 2005, 2010, and 2015.[3] An unusual feature of the dataset is that the data are disaggregated by industry, giving us 10 different industry observations per nation-year. Industry-level data provide attractive analytic opportunities because industrial variations in wage intensity are likely to be substantial. While our primary interest is national differences in multipliers, national multipliers are likely to be affected by industrial composition. Thus, considering the properties of industries in and of themselves informs the national analysis. We begin with a brief analysis of the inter-industrial variation. Given the small number of cases for an inter-industrial analysis, we rely on a series of simple bivariate correlations.

The attractive ability to analyze nation-year industries also complicates the statistical analysis. As is common in time-series cross-section datasets, error terms are clustered by nation and by period, so the errors are not technically independent (Beck 2001). In these data, errors are also clustered by industry. There are standard time-series cross-section methodologies for providing efficient estimations for data clustered by *two* factors, such as period and region. Fixed effects models (Wallace and Hussain 1969) and panel-corrected standard error models (Beck and Katz 1995) are well-accepted and useful techniques. But no standard methodology exists for data with errors clustered by *three* factors.

There is a further complication that area is constant for all observations in the same nation. Thus methodologies that attempt to extract a composite error term for nation-based effects crash because that term is perfectly collinear with area—a substantive variable in the analysis.

We use two approaches in dealing with these issues. First, we use intuitive, simple estimation procedures demonstrating robustness by the use of large numbers of similar equations on subsets of the data. For all dependent variables, we present bivariate correlations with our predictor variables as well as simple OLS equations for our core model plus a number of controls. To show that our findings are not artifacts of unmeasured nation, period, or industry effects, we run parallel equations within nations, years, and industries. We use OLS to run our core model of domesticity, wage intensity, and area first within each year, then within each industry, and then within each nation. The within-year runs are buffered from year-specific effects; the within-industry runs are buffered from industry-specific effects; and the within-nation runs are buffered from nation-specific effects. We cannot estimate the effect of area with within-nation equations due to each nation's having a constant area. But otherwise, each relationship is subject to multiple analyses that neutralize the three different forms of correlated errors. This generates a large number of equations—too many to fully reproduce here. For ease of interpretation, we provide a summary of the within-year, within-industry, and within-nation effects, showing the percentage of equations that generate statistically significant coefficients with the correct sign.

Because GDP per capita and education are highly collinear, we never run these in the same model. All tests of development levels involve the set {domesticity, wage intensity, and (where possible) area} and then *one* of the two development variables.

We also present traditional fixed effects models. These pool the errors associated with individual nations and with individual years to provide a more efficient estimate of substantive effects (Wooldridge 2010). While fixed effects methods are now common in sociology and political science, they have their intrinsic limits. If there are unmeasured systematic variables associated with nation, the results of a fixed effects model will be neither efficient nor unbiased. This dataset has an obvious variable that is strongly associated with nation: the area of the nation. We believe that OLS models that explicitly control for area provide a more theoretically rigorous specification of nation effects than would be obtained by just letting nations have their own error term. However, we acknowledge that this analysis cannot rule out the presence of other confounding nation-level effects.

We start with an initial discussion of industry effects. Industrial composition is a plausible determinant of national difference in multipliers. To understand this, it is useful to examine the distribution of multiplier size by industry and the causes of these differences. We then turn to a more general presentation of our findings.

## FINDINGS

### Industry Effects

Table 1 shows the average multiplier by industry for all three types for the year 2015. The other years (2005 and 2010) are omitted because the findings are nearly identical. The averages are based on the original 61 nations in our sample.

Just as nations vary in the size of their multipliers, so do industries. The highest Type II (total) multiplier comes from government services, followed by construction. The lowest is observed in mining and quarrying. For the Type I (industrial) effect, we observe manufacturing as the largest, followed closely by construction. Both manufacturing and

TABLE 1. Mean Total (Type II), Industrial (Type I), and Wage (Type II–I) Multiplier Effects by Industry in 2015

| Industry | Type II | Type I | Type II–I |
|---|---|---|---|
| Government services (incl. health and education) | 3.98 (0.92) | 1.38 (0.13) | 2.6 (0.88) |
| Construction | 3.11 (0.65) | 1.73 (0.24) | 1.38 (0.54) |
| Finance | 3.06 (0.74) | 1.51 (0.16) | 1.55 (0.66) |
| Wholesale, retail trade, hotels, and restaurants | 3.04 (0.67) | 1.49 (0.16) | 1.55 (0.59) |
| Transportation, storage, and communications | 2.94 (0.57) | 1.64 (0.17) | 1.3 (0.48) |
| Manufacturing | 2.88 (0.61) | 1.74 (0.23) | 1.15 (0.46) |
| Other services (incl. real estate) | 2.84 (0.48) | 1.49 (0.14) | 1.35 (0.44) |
| Electricity and water | 2.71 (0.47) | 1.69 (0.24) | 1.02 (0.37) |
| Agriculture, forestry and fishing | 2.64 (0.62) | 1.61 (0.19) | 1.02 (0.53) |
| Mining and quarrying | 2.6 (0.69) | 1.52 (0.22) | 1.08 (0.54) |

Notes: $N$ = 61, standard deviations in parentheses.

construction are huge consumers of capital inputs from other industries, which may explain their higher multipliers. The lowest industrial effect is found in government services. This is somewhat expected as government's strength, in terms of multipliers, lies in its high employment–high wage nature (e.g., teachers, nurses, bureaucrats) rather than in its consumption of industrial inputs (e.g., machinery).

Government services' employment and wage capacity is reflected in its large Type II–I (wage) multiplier effect, which is the largest of all industries considered. Note also the superior effect coming from the wholesale, retail, hotel, and restaurant sector, as well as finance, all of which are highly labor-intensive. The lowest wage effects are from agriculture, forestry and fishing, and electricity and water.

The industry-specific multipliers are essentially determined by wage intensity. The wage intensity of industries increases their Type II and Type II–I multipliers. The capital intensity of industries increases their Type I multipliers, causing wage intensity to have a negative effect. The argument here is the same as that provided for national multipliers as a whole.

Table 2 shows the bivariate correlation between the average multiplier type (Type II, Type I, and Type II–I) from the 61 nations in our sample for 2015. (Results for the other years are similar.) The correlations within industries between wage intensity and Type II and Type II–I multipliers are 0.95 and 0.99, respectively. The industrial correlation between wage intensity and Type I is −0.75; this is not as dramatically high as the findings for the other two types of multipliers, but the finding is very strong. Once wage intensity has been taken into account, there is not a lot of industrial multiplier variance left to explain.

No other variable in our model explains much of the variance. In any nation, both the area and the national level of development are constant, eliminating any ability to explain within-nation industrial variance. Industries vary little in their propensities to import. While nations show substantial variance in the domesticity of production, within nations, individual industries have fairly similar ratios of imported to domestic content.

The extremely high correlation between wage intensity and industry multipliers obviates the need to control for industrial composition in the analyses that follow. The wage intensity variable in our equations captures both the wage intensity that comes from industrial composition and the wage intensity that comes from cross-industry nation-specific effects. We discuss the combined wage intensity effect, which is a key determinant of multipliers.[4]

TABLE 2. Correlation Coefficients between Total (Type II), Industrial (Type I), and Wage (Type II–I) and Wage Intensity by Industry in 2015

| Industry multiplier | Industry wage intensity |
|---|---|
| Type II | 0.95 |
| Type I | −0.76 |
| Type II–I | 0.99 |

*N* = 10

## General Overview of Results

Because the results we report in the rest of the paper are complex, we provide an overview of the general findings here. Table 3 provides a summary.

We predicted that:

- Domesticity would have a positive effect on all multipliers. It does so on all tests except those involving OLS within nations.
- Wage intensity would have a positive effect on Type I multipliers and a negative effect on Type II and II–I multipliers. It does so in all tests except those involving fixed effect models.
- Area would have a positive effect on all multipliers. It does so in 9 out of 12 tests.

TABLE 3. Summary of Results by Type of Multiplier and Estimation Method (Robust Standard Errors)

| | Bivariate correlation | OLS whole sample | OLS within year | OLS within industry | OLS within nation (no area) | Fixed effects whole sample (no area) |
|---|---|---|---|---|---|---|
| *Type II (total)* | | | | | | |
| Domesticity | + | +* | +* | +* | 0* | + |
| Wage intensity | + | +* | +* | + | +* | 0 |
| Area | + | +* | +* | +* | n.a. | n.a. |
| GDP per capita | - | –* | –* | - | 0* | 0 |
| Education | 0 | –* | 0 | 0* | 0* | - |
| *Type I (industrial supply)* | | | | | | |
| Domesticity | + | +* | +* | +* | 0* | + |
| Wage intensity | - | –* | –* | - | –* | 0 |
| Area | 0 | +* | +* | 0* | n.a. | n.a. |
| GDP per capita | 0 | +* | 0* | 0* | 0* | 0 |
| Education | 0 | +* | +* | +* | 0* | 0 |
| *Type II–I (worker consumption)* | | | | | | |
| Domesticity | + | +* | +* | +* | 0* | + |
| Wage intensity | + | +* | +* | + | +* | 0 |
| Area | 0 | +* | +* | +* | n.a. | n.a. |
| GDP per capita | - | –* | –* | –* | 0* | - |
| Education | 0 | –* | –* | 0* | 0* | - |

*Cross-confirmed with clustered standard error analysis.

NOTE: +, positive; -, negative; 0, zero; n.a., not available.

- Per capita GDP would have a positive effect on Type I and a negative effect on Type II–I. The Type I prediction fails, with five out of six tests showing no effect. The Type II–I prediction holds for five out of six tests. For Type II (total) multipliers, two-thirds of the tests show a negative effect.
- The same predictions were made for education. The results here are even spottier. Half of the Type I and the Type II–I predictions fail. Two-thirds of the tests relating education to Type II (total) multipliers show no effect.

Overall, the predictions for domesticity, wage intensity, and area are supported, while the development variables appear to have a more minor role.

### Total Multipliers

Tables 4, 5, 6, and 7 show bivariate correlation, full OLS, within-category OLS equations, and fixed effect models (respectively) predicting total multipliers. For the core variables, the bivariate correlations and full OLS show the same results, confirming the predictions of our model. Domesticity is positively and significantly related to the size of total multipliers. Domesticity here refers to the domesticity of consumption goods. Results not presented here show similar but slightly weaker findings for the domesticity of industrial supplies. Wage intensity has the strongest effect, with a Pearson correlation of 0.51 with total multipliers. The regression coefficients show similar results. Area is also positively and significantly related to total multipliers, although the Pearson correlation of 0.22 is modest.

Results for socioeconomic development are weaker. GDP is only correlated with total multipliers at the 0.2 level. Education is entirely uncorrelated. Both do better in the OLS regressions.

In the within-category regressions, wage intensity and area do well in nearly all of their tests. No more than one or two equations in each set produce adverse results. Domesticity is an equally strong performer in within-year and within-industry equations. It does not do well in within-nation equations. Domesticity fails in a large majority of cases here. GDP per capita has a performance pattern similar to that of domesticity: it does well in within-year and within-industry equations and generally fails in within-nation

TABLE 4. Bivariate Correlation of Selected Variables and Total Multipliers (Type II), $N = 1{,}830$

| | Type II multiplier |
|---|---|
| Household domesticity | 0.312 |
| Wage intensity | 0.510 |
| Area ($km^2$) | 0.225 |
| GDP per capita | −0.205 |
| Education | −0.066 |

TABLE 5. OLS Estimates of the Effect of Selected Variables on Total Multipliers (Type II), $N$ = 1,830

| | Normal | + GDP per capita | + Education |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| Household domesticity | 0.674 (0.074) | 0.565 (0.073) | 0.641 (0.074) |
| Wage intensity | 2.33 (0.097) | 2.41 (0.095) | 2.36 (0.097) |
| Area (km$^2$) | 0.492e-8 (4.79e-9) | 4.73e-8 (4.66e-9) | 4.93e-8 (4.77e-9) |
| GDP pc | | −7.13e-06 (6.67e-07) | |
| Education | | | −0.025 (0.006) |
| *R*-squared | 0.342 | 0.380 | 0.348 |

*Notes:* Robust standard errors in parentheses.

comparisons. Education does poorly in all types of within-category equations. Forty percent or fewer of education tests produce favorable results.

The fixed effect models' findings do not parallel those of the other tests. Area is not included in the fixed effects models (or in the within-nation OLS regressions) because of its perfect collinearity with nation. In these equations, domesticity performs well, and so do both socioeconomic development variables, GDP per capita and education. Wage intensity suffers its only failure in the series.

Overall, no variable fails in every estimation or does perfectly in every estimation. However, the three core variables, domesticity, wage intensity, and area, do well in a large majority of their tests. The performance of the socioeconomic development variables is weaker. However, they are in general correctly signed and can perform well even in demanding equations.

### Industrial Supply Multipliers

In the bivariate correlations, only domesticity and wage intensity perform well, with correlations of 0.2 or higher (Table 8). However, performance significantly improves in the OLS equations (Table 9). In whole-sample runs, everything is significant and in the correct direction.

For the within-category equations (Table 10), domesticity and wage intensity do well in the within-year and within-industry runs. However, both generally fail in within-nation runs. Area does well in within-year runs but fails in within-nation runs. GDP fails in the vast majority of within-category runs. Education does better, performing well in any within-category run that is not a within-nation analysis.

In the fixed effects model (Table 11), virtually everything fails except for domesticity, which is robust in all equations. Overall, only domesticity predicts Type I (industrial supply) multipliers in every analysis. However, wage intensity and area do well in most of their tests. Outside of pooled OLS analyses, socioeconomic variables struggle.

TABLE 6. Number of Equations within Each Analytical Category That Produce Correctly Signed Significant Coefficients in OLS Equations Predicting Type II Multipliers within Analytical Categories

| | Year (3 separate individual-year equations) | | | Industry (10 separate individual-industry equations) | | | Nation (61 separate individual-nation equations) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) |
| Household domesticity | 3 of 3 | 3 of 3 | 3 of 3 | 6 of 10 | 7 of 10 | 7 of 10 | *Only 9 of 61* | *Only 10 of 61* | *Only 10 of 61* |
| Wage intensity | 3 of 3 | 3 of 3 | 3 of 3 | 8 of 10 | 8 of 10 | 8 of 10 | 60 of 61 | 60 of 61 | 60 of 61 |
| Area ($km^2$) | 3 of 3 | 3 of 3 | 3 of 3 | 9 of 10 | 9 of 10 | 9 of 10 | n.a. | n.a. | n.a. |
| GDP per capita | - | 3 of 3 | - | - | 8 of 10 | - | - | *Only 7 of 61* | - |
| Education | - | - | *Only 1 of 3* | - | - | *Only 4 of 10* | - | - | *Only 19 of 61* |
| *N* per equation | 608 | 608 | 608 | 183 | 183 | 183 | 30 | 30 | 30 |

TABLE 7. Fixed-Effects Models of the Effect of Selected Variables on Total Multipliers (Type II), $N$ = 1,830.

| | Normal | + GDP pc | + Education |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| Household domesticity | 3.409 (0.619) | 2.629 (0.721) | 1.898 (0.860) |
| Wage intensity | 0.127 ns (0.361) | 0.107 ns (0.356) | 0.090 ns (0.354) |
| GDP per capita | | −5.04e-6 (2.47e-6) | |
| Education | | | −0.073 (0.030) |
| $R^2$ within | 0.273 | 0.298 | 0.309 |
| $R^2$ between | 0.438 | 0.400 | 0.219 |
| $R^2$ overall | 0.418 | 0.388 | 0.228 |

*Notes:* Standard errors in parentheses; ns = not significant.

TABLE 8. Bivariate Correlation of Selected Variables and Industrial Supply Multipliers (Type I), $N$ = 1,1830

| | Type I multiplier |
|---|---|
| Industrial domesticity | 0.216 |
| Wage intensity | −0.334 |
| Area ($km^2$) | 0.164 |
| GDP per capita | 0.002 |
| Education | 0.052 |

TABLE 9. OLS Estimates of the Effect of Selected Variables on Industrial Supply Multipliers (Type I), $N$ = 1,830

| | Normal | + GDP per capita | + Education |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| Household domesticity | 0.485 (0.042) | 0.512 (0.043) | 0.527 (0.041) |
| Wage intensity | −0.553 (0.031) | −0.562 (0.031) | −0.577 (0.030) |
| Area ($km^2$) | 6.01e-9 (1.61e-9) | 6.00e-9 (1.61e-9) | 5.65e-9 (1.57e-9) |
| GDP per capita | | 7.84e-7 (2.33-7) | |
| Education | | | 0.019 (0.002) |
| $R$-squared | 0.197 | 0.202 | 0.237 |

*Notes:* Robust standard errors in parentheses. All coefficients are correctly signed and significant at the .05 level.

TABLE 10. Number of Equations within Each Analytical Category that Produce Correctly Signed Significant Coefficients in OLS Equations Predicting Type I Multipliers within Analytical Categories

| | Year (3 separate individual-year equations) | | | Industry (10 separate individual-industry equations) | | | Nation (61 separate individual-nation equations) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) |
| Industrial domesticity | 3 of 3 | 3 of 3 | 3 of 3 | 10 of 10 | 10 of 10 | 10 of 10 | *Only 8 of 61* | *Only 8 of 61* | *Only 7 of 61* |
| Wage intensity | 3 of 3 | 3 of 3 | 3 of 3 | 7 of 10 | 7 of 10 | 6 of 10 | *Only 20 of 61* | 45 of 61 | 44 of 61 |
| Area ($km^2$) | 2 of 3 | 2 of 3 | 2 of 3 | *Only 2 of 10* | Only 1 of 10 | Only 1 of 10 | n.a. | n.a. | n.a. |
| GDP per capita | - | 1 of 3 | - | - | 4 of 10 | - | - | Only 1 of 61 | - |
| Education | - | - | 3 of 3 | - | - | 8 of 10 | - | - | Only 2 of 61 |
| *N* per equation | 608 | 608 | 608 | 183 | 183 | 183 | 30 | 30 | 30 |

TABLE 11. Country and Year Fixed Effects on Industrial Multipliers (Type I), $N$ = 1,830

| | Normal | + GDP per capita | + Education |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| Household domesticity | 0.552 (0.118) | 0.614 (0.150) | 0.616 (0.190) |
| Wage intensity | −0.077 ns (0.125) | −0.074 ns (0.125) | 0.074 ns (0.125) |
| GDP per capita | | 6.3e-7 ns (9.32e-7) | |
| Education | | | 0.005 ns (0.012) |
| $R^2$ within | 0.182 | 0.185 | 0.183 |
| $R^2$ between | 0.343 | 0.363 | 0.412 |
| $R^2$ overall | 0.316 | 0.336 | 0.378 |

*Notes:* Standard errors are in parentheses; ns = not significant.

## Worker Consumption Multipliers

The findings for worker consumption multipliers are similar to those for total multipliers. At the bivariate level (Table 12), all variables are correlated in the correct direction. The bivariate correlation for wage intensity is substantially higher than those of the other variables. The correlations for area and for education are marginal. All these problems disappear in the pooled OLS (Table 13), where every variable is correctly signed and in the correct direction.

In the within-category equations (Table 14), wage intensity has the strongest findings, as was the case with the bivariate correlations. Nearly all of its tests are significant and in the correct direction. Area's findings are nearly as strong, with generally positive results throughout. Domesticity does well in all runs except within-nation ones. The socioeconomic variables all do well in within-year and within-industry runs; they generally fail in within-nation runs.

In the fixed effects models (Table 15), everything works except wage intensity.

## Clustered Standard Error Analyses

The OLS analyses just reported were replicated with clustered standard error analyses. Estimates for the sample as whole and for within-industry analyses had errors clustered by

TABLE 12. Bivariate Correlation of Selected Variables and Worker Consumption Multipliers (Type II–I), N = 1,830

| | |
|---|---|
| Household domesticity | 0.313 |
| Wage intensity | 0.632 |
| Area ($km^2$) | 0.184 |
| GDP per capita | −0.214 |
| Education | −0.115 |

TABLE 13. OLS Estimates of the Effect of Selected Variables on Worker Consumption Multipliers (Type II–I), $N = 1{,}830$

| | Normal | + GDP per capita | + Education |
| --- | --- | --- | --- |
| | Model 1 | Model 2 | Model 3 |
| Household domesticity | 0.555 (0.065) | 0.436 (0.063) | 0.468 (0.064) |
| Wage intensity | 2.84 (0.084) | 2.93 (0.082) | 2.90 (0.083) |
| Area (km$^2$) | 3.83e-8 (4.18e-9) | 3.633e-8 (4.00e-9) | 3.85e-8 (4.11e-9) |
| GDP per capita | | −7.56e-6 (5.73-7) | |
| Education | | | −0.043 (0.005) |
| *R*-squared | 0.457 | 0.503 | 0.475 |

*Notes:* Robust standard errors in parentheses. All non-italicized coefficients are correctly signed and significant at the .05 level.

nation and by year. Within-year analyses were clustered by nation only. Within-nation analyses were clustered by year. All of the whole-sample, within-year, and within-nation analyses were fully replicated. Twelve of the fifteen within-industry analyses were replicated. One seemingly zero finding became significant and in the correct direction in the clustered run. Overall, the results presented here are robust to the choice of estimating technique for the standard errors.

### Dealing with the Inconsistencies among Estimates

Overall, all of the variables receive support in most of the estimations. None has universally successful results, and none has universally unsuccessful results.

Generally, as well, the estimations that pose the most problems for variables are the within-nation OLS runs and the fixed effect models. We view the within-nation OLS analyses and the fixed effect models as the most methodologically fragile equations that we present. We put the greatest weight on the pooled OLS analyses and a bit less weight on the within-year and within-nation analyses.

What are the problems with the within-nation analyses? These have the smallest *N*. The pooled analyses have an *N* of 1,830; within-year analyses, 610; within-industry analyses, 182; and within-nation analyses, 30. With 30 cases, data attrition is a serious problem. Regressions with three predictors are difficult to sustain.

Within-nation analyses have the further aspect of being heavily driven by industry differences. National differences in propensity to import are kept constant. Area is also parametric. So these analyses are largely contrasts between industries. Industry multipliers, as we have seen, are overwhelmingly determined by wage intensity. These tests don't allow for the greater variance in domesticity and socioeconomic development that would be observed in cross-nation comparisons.

The fixed effects models are subject to misspecification due to area being an unmeasured variable that is strongly related to the individual-nation errors. There is no

TABLE 14. Number of Equations within Each Analytical Category that Produce Correctly Signed Significant Coefficients in OLS Equations Predicting Type II–I Multipliers within Analytical Categories

| | Year (3 separate individual-year equations) | | | Industry (10 separate individual-industry equations) | | | Nation (61 separate individual-nation equations) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) | Model 1 (normal) | Model 2 (+ GDP) | Model 3 (+ edu.) |
| Household domesticity | 3 of 3 | 3 of 3 | 3 of 3 | 6 of 10 | 7 of 10 | 7 of 10 | *Only 6 of 61* | *Only 7 of 61* | *Only 7 of 61* |
| Wage intensity | 3 of 3 | 3 of 3 | 3 of 3 | 9 of 10 | 9 of 10 | 9 of 10 | 61 of 61 | 61 of 61 | 61 of 61 |
| Area ($km^2$) | 3 of 3 | 3 of 3 | 3 of 3 | 8 of 10 | 8 of 10 | 9 of 10 | n.a. | n.a. | n.a. |
| GDP per capita | - | 3 of 3 | - | - | 8 of 10 | - | - | *Only 13 of 61* | - |
| Education | - | - | 3 of 3 | - | - | 7 of 10 | - | - | *Only 21 of 61* |
| *N* per equation | 608 | 608 | 608 | 182 | 182 | 182 | 30 | 30 | 30 |

TABLE 15. Country and Year Fixed Effects on Worker Consumption Multipliers (Type II–I), $N$ = 1,830

| | Normal | + GDP per capita | + Education |
|---|---|---|---|
| | Model 1 | Model 2 | Model 3 |
| Household domesticity | 3.409*** (0.619) | 2.629*** (0.721) | 1.898* (0.860) |
| Wage intensity | 0.127 ns (.361) | 0.107 ns (0.356) | 0.090 ns (0.354) |
| GDP per capita | | -5.04e-6 (2.47e-6) | |
| Education | | | −0.073* (0.030) |
| $R^2$ within | 0.273 | 0.298 | 0.309 |
| $R^2$ between | 0.438 | 0.400 | 0.219 |
| $R^2$ overall | 0.418 | 0.388 | 0.228 |

*Notes:* Robust standard errors in parentheses; ns = not significant.

methodology for getting a clean estimate of nation effects net of area. However, the absence of area leads to bias and inefficiency in the estimates. It is a further problem in within-nation analyses, too.

Thus, we are inclined to put more weight on the results from bivariate correlations, pooled OLS, and year-specific and industry-specific regressions than on the other two estimations. The four more robust estimations all show strong results for domesticity, wage intensity, area, and education. GDP per capita does well in some of the more robust estimations but fails in a relatively large number of tests.

## CONCLUSION

We have argued that Leontief multipliers deserve more attention than they are getting from development sociologists. Nations differ dramatically in their multipliers, a finding that was shown graphically in our maps. These differences do not replicate the stereotypes of "strong growers" and "weak growers" that would be expected from simple levels of overall development. But Leontief multipliers are an important component of overall economic growth. Nations with high multipliers should be more successful in converting growth in their base industries into economic growth that is widely dispersed throughout their economy, providing benefits to the population as a whole.

Nations that do not import have higher multipliers than those that do. Nations that employ lots of workers and who pay those workers well have higher multipliers than those that do not (with the exception of industrial supply multipliers, which benefit more from capital intensity). Geographically large nations have large multipliers.

These findings provide support to advocates of import substitution by providing another mechanism by which local production can be shown to contribute to overall economic growth. They do not identify the mechanisms through which imports should be limited, or domestic production raised. Formal policies of tariffs and import licensing are not the only or even the best mechanism for supporting local production. Williamson (2006) has argued that having a weak currency is sufficient to reduce imports of industrial and consumer goods and to stimulate the increase of local manufacture. He demonstrates this by showing the beneficial effects in Latin America of the collapse of local currencies during the Great Depression. The devaluations that followed the financial crises of the late 1920s and early 1930s led to dramatic increases in Latin American industrialization (see also Furtado 1970). Developmentalist state policies that directly stimulate the creation of manufacturing capacity in its own right can have similar effects (Amsden 2001; Wade 1990).

These results support the argument of social democratic writers that high employment and high wages stimulate economic growth in a Keynesian manner. This is a contrast with neoliberal writers, who have argued that the key to economic growth is international competitiveness and that the key to international competitiveness is the reduction of labor costs. We argue that such approaches ignore the importance of domestic markets. Local consumer goods and local services are an important component of overall demand. Housing, bars, restaurants, beauty shops, local food specialties, health services, and religious services are ignored by development specialists who want to concentrate on industries that are "truly transformative." But these ordinary, routine economic sectors provide real jobs and create real wealth. Increasing employment and wages so workers can obtain these goods and services is a much-neglected feature of national development plans.

## LIMITATIONS AND FUTURE WORK

While our findings have valuable policy-related implications, there remain limitations based on data availability and policy applicability. Due to data attrition, our study focuses on middle- and high-income countries. As new, reliable data become available for lower-income countries, studies including these cases will be invaluable for a more holistic comparison of national multiplier differences. The nature of national political, economic, and social diversity also poses a challenge. Our study discusses some ways to promote economic growth, but there are many ways, and the choice of policy tools will ultimately always depend on local considerations. One of our most important findings is the suggestion that transportation and the provision of transportation services are critical components of development. However, countries cannot meaningfully expand the size of their nations, unless we consider the perverse exception of wars of conquest. Thus, geographical area is a meaningful consideration only so far as it can influence transportation-related policy.

There are undoubtedly other determinants of multiplier size besides those presented here. Industries vary in the size of their multipliers, and encouraging the expansion of industries with high multipliers by itself would represent a pro-development policy. Overall, multipliers and input–output analysis need to return to the center rather than the periphery of development discourse. Future research should continue to focus on the study of multipliers, their national differences, their inter-industry differences, and their determinants. ■

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## NOTES

1. The 11 categories we use for our multipliers are agriculture, mining, manufacturing, electricity, construction, wholesale, transport, finance, government, other services, and households.

2. In earlier analyses, we considered population size as an alternative to physical area. Physical area has a theoretically coherent link to transportation employment, while population is not associated with an equally credible causal mechanism. Statistically, population itself showed almost no empirical correlation with multiplier size.

3. We are grateful to Salvatore Babones for much of the section that follows. This includes the analysis of the unsuitability of traditional TSCS methodologies for this dataset, the identification of the collinearity issue, and the use of multiple repetitive OLS equations within time, nation, and industry categories. The responsibility for any inadequacies in the analysis is of course our own.

4. Whether wage intensity is best increased by promoting labor-intensive industries or promoting labor intensity within industries probably depends on practical circumstances particular to each national economy.

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## APPENDIX: THE CALCULATION OF LEONTIEF MULTIPLIERS

Multipliers are the additional economic growth that occurs as a result of an increase in activity in a basic industry. The three most important forms of multipliers are total multipliers, purchases by the base industry of supplies from other industries, and consumer purchases by workers with salaries earned in the base industry (see the definitions of Type II, Type I, and Type II–I multipliers in the main text).

Leontief matrices, also called input–output tables, summarize all the transactions within a sector of an economy between businesses, households, government, and foreign inputs in a given year. The conceptual basis of input–output analysis and the methods by which multipliers are calculated can be found in any textbook on input–output analysis. The treatment here follows Miller and Blair's 2009 work. See Miernyk (1965) or Ten Raa (2014) for essentially parallel treatments.

Leontief matrices have three main sections: intermediate transactions between industries; final demand per industry; and value added per industry, all for a given year, as seen in Figure 1. We calculated multipliers from the domestic transfers in the DOMIMP input–output tables

TABLE A1. Input–Output Table Structure

| | | Producers as consumers | | | | Final demand | |
|---|---|---|---|---|---|---|---|
| | | Industry 1 | Industry 2 | ... | Industry n | Household consumption | Other final demand* |
| Producers | *Industry 1* | USD millions | USD millions | ... | USD millions | USD millions | USD millions |
| | *Industry 2* | ... | ... | ... | ... | ... | ... |
| | ... | ... | ... | ... | ... | ... | ... |
| | *Industry n* | USD millions | USD millions | ... | USD millions | USD millions | USD millions |
| Value added | *Employee compensation* | USD millions | ... | ... | ... | GDP | |
| | *Other value added*** | USD millions | ... | ... | ... | | |

*Other final demand categories vary by table, but often include government purchases and net exports.

**Other value-added categories may include taxes on production and consumption of fixed capital.

(https://stats.oecd.org/Index.aspx?DataSetCode=IOTS_2021) on the OECD website (Table A1).

Each of these sections may have a varying level of detail, from general industries such as "manufacturing" to very specific ones, such as "manufacture of paper products." Aggregation from more specific to more general industry classifications is possible, to enable comparison between tables with different levels of detail.

In this study, we compute multipliers in two ways: by treating households as part of final exogenous demand; and by endogenizing households, treating them as an industry, with labor (measured by compensation of employees) as their output which is consumed by other industries. The multipliers calculated by the former method are the Type I or "industrial supplies" multipliers, as they depend only on the additional purchases made by businesses, not households. Type II multipliers, also called "total" multipliers, are calculated using the latter method and capture the additional production that occurs when workers make purchases with their new income.

To calculate the multiplier for the *j*th industry in an input–output table, we find the change in total output, $\Delta X$, when the change in final demand, $\Delta F$, is 1 for the *j*th industry and 0 for all other industries. For example, the multiplier for industry 1 is

$$m_1 = \begin{pmatrix} l_{1,1} & \cdots & l_{1,n} \\ \vdots & \ddots & \vdots \\ l_{n,1} & \cdots & l_{n,n} \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \sum_{i=1}^{n} l_{i,1} \quad (1)$$

So, generally, the multiplier for industry $j$ is the sum of all entries in column $j$ of the Leontief inverse, as this represents the total increase in output in each industry when the final demand for industry $j$'s products is increased by one unit, all else equal. When the model is open with respect to households, the multiplier generated is the Type I (industrial supplies) multiplier—the shaded area in Table A2.

TABLE A2. Input–Output Table with Shaded Industries Treated as Endogenous for Type I Multiplier

| | | Producers as consumers | | | | Final demand | |
|---|---|---|---|---|---|---|---|
| | | Industry 1 | Industry 2 | . . . | Industry n | Household consumption | Other final demand |
| Producers | *Industry 1* | | | | | | |
| | *Industry 2* | | | | | | |
| | . . . | | | | | | |
| | *Industry n* | | | | | | |
| Value added | *Employee compensation* | | | | | | |
| | *Other value added* | | | | | | |

TABLE A3. Input–Output Table with Shaded Industries Treated as Endogenous for Type II Multiplier

| | | Producers as consumers | | | | | |
|---|---|---|---|---|---|---|---|
| | | Industry 1 | Industry 2 | . . . | Industry n | Households (industry n + 1) | Other final demand |
| Producers | *Industry 1* | | | | | | |
| | *Industry 2* | | | | | | |
| | . . . | | | | | | |
| | *Industry n* | | | | | | |
| | *Employee compensation (industry n + 1)* | | | | | | |
| Value added | *Other value added* | | | | | | |

When households are endogenized as the $(n + 1)$th industry (with private consumption as its output and wages as its input), the Type II (total) multiplier is generated. The part of the input–output table considered for intermediate consumption is shaded in Table A3.

In our analysis, we also calculate the worker and consumer expenditures multiplier, which is the difference between the Type II and Type I multipliers, providing a measure of the extra growth attributable to feeding worker compensation back into the economy as household consumption.

Type I (industrial supplies) multiplier $=\sum_{i=1}^{n+1} l_{ij}$

Type II – Type I (worker and consumer expenditures multiplier) = $i_{(n+1)j}$

Type II (total) multiplier =\scale140%{{\displaystyle $\sum_{i=1}^{n} l_{ij}$