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Multinational Production: Data and Stylized Facts[†]

By Natalia Ramondo, Andrés Rodríguez-Clare, and Felix Tintelnot*

Globalization is a phenomenon of many dimensions: international trade and migration, financial integration, multinational production, international knowledge flows, etc. We are concerned here with multinational production (MP), defined as production that is carried out by firms outside of their country of origin. There are several important questions associated with MP: To what extent are firms becoming multinational? How is this affecting worldwide efficiency? What are the effects on home and host country welfare? Is the trend toward increasing levels of multinational production facilitating income convergence across countries? What are the effects on inequality within and across countries?

There exists, of course, a large theoretical and empirical literature tackling these questions (e.g., Antràs and Yeaple 2014). On the empirical side, most of the work has been done with data on foreign direct investment (FDI). To some extent, the reliance on FDI data comes from the fact that early theorizing focused on the transfer of capital associated with FDI. For the most part, however, it comes from the fact that FDI data are readily available, while more direct measures of MP are much scarcer. In this paper we introduce a new dataset on MP and present a series of stylized facts motivated by recent quantitative models of trade and MP (e.g., Ramondo and Rodríguez-Clare 2013; Arkolakis et al. 2013;

and Tintelnot 2014). For many of the questions above, MP flows are a more appropriate empirical object than FDI.[1] This is because the importance of a subsidiary depends on the magnitude of its production activity (which we proxy by sales) rather than the way in which it is financed. For example, if the investment to open a subsidiary were financed from local sources, this would not show up as FDI, but it would appear in our MP data.

Our analysis of the MP data emphasizes the analogies between MP and international trade because these two flows are intimately related. On the one hand, trade and MP are substitutes in that they are alternative ways by which firms can serve foreign markets or take advantage of low priced factors of production in foreign countries. On the other hand, trade and MP are complements in that foreign subsidiaries of multinational firms are intensively engaged in both imports (for inputs) and exports to third countries. We measure bilateral MP flows from country i to country l by the sales of foreign affiliates in country l that belong to country i multinationals. This is analogous to bilateral trade flows. More formally, if X_{iln} are the sales in market n by subsidiaries in location l that belong to multinationals from country i, MP flows from i to l result when we sum X_{iln} over n, $Y_{il} = \sum_n X_{iln}$—and we do not keep track of the destination of the sales, while trade flows from l to n result when we sum X_{iln} over i, $X_{ln} = \sum_i X_{iln}$—and we do not keep track of the country of origin of the firms making the sales.

Our dataset is a cross section of aggregate bilateral MP flows and counts (i.e., number of affiliates) across 59 countries for the late 1990s. As far as we know, there are three alternative datasets on bilateral MP. Alfaro and Charlton (2009) use firm-level data provided by Dun and

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[1] There are some papers that explicitly distinguish between FDI and MP (see, for example, Antràs, Desai, and Foley 2009 and McGrattan and Prescott 2009).

Bradstreet. These are registry data, so while there is useful information at the firm level, there is a concern about accuracy in the aggregation to the country level.[2] Despite using smaller samples of countries, Fukui and Lakatos (2012) and Alviarez (2014) take important steps in assembling bilateral MP data disaggregated by sectors, with Eurostat FATS as the main data source.[3]

I. Data

The construction of the MP database combines several sources, the main one being published and unpublished data by UNCTAD. The UNCTAD dataset includes the sales by affiliates of foreign firms, the number of local affiliates owned by foreign firms, and their employment and asset value.[4] We focus on a sample of 59 countries, which entails 3,422 (58 × 59) possible observations. Each observation is an aggregate over non-financial sectors constructed as an average over the period 1996–2001.

A problem with the UNCTAD data is the large number of missing values. We use data on the value and count of mergers and acquisitions (M&A) from Thomson and Reuters to fill in missing observations.[5] M&A data are highly informative about bilateral MP: for the set of country pairs for which we have both variables, the correlation between the bilateral number of M&A transactions and bilateral MP is 0.82 (in logs), while for the bilateral number of affiliates, it is 0.87 (in logs). Our extrapolation procedure brings down the number of missing values for bilateral MP and bilateral number of affiliates

from 1,111 and 1,190 observations to 728 and 692, respectively. The resulting dataset has a large number of zeros: of a total of 2,694 observations with nonmissing values, 1,215 present some MP activity, while the rest have zero MP. Finally, it is worth mentioning that FDI stocks, a commonly used bilateral measure of MP activity, have a strong correlation with our measure of MP: the correlation between MP sales and FDI stocks is 0.85, both in levels and logs. Nonetheless, the levels for the two variables are different: as a share of (nonfinancial) gross production in the host country, our measure of MP activity entails an average inward MP flow of 17 percent, while FDI stocks represent 10 percent. This difference turns out to be important for inference about the level of openness for a country, as we explain below: using FDI stocks would make some countries appear as less open to MP.

The supplemental online material presents a detailed description of the data and the extrapolation procedure.

II. Gravity and the Margins of MP

We revise the evidence on MP gravity, including the extensive and intensive margins of MP, and we compare it with trade gravity, using bilateral trade flows in all goods from Feenstra et al. (2005). The extensive margin of MP refers to (i) the presence or not of affiliates from i in country n and (ii) given that country i has MP presence in n, the number of affiliates of firms from i in n.[6] The extensive margin of trade simply refers to the lack or presence of trade flows from country i into n—we do not have the analogue of (ii) for the trade data (e.g., the number of exporters from i into n).

Let $\lambda_{il}^M \equiv Y_{il}/Y_l$ denote affiliate revenues of firms from i in l, as a share of gross production (in nonfinancial sectors) in country l; and $\lambda_{il}^T \equiv X_{ln}/X_n$ denote trade flows from l to n, as a share of expenditure in country n (calculated as gross production in nonfinancial sectors minus exports plus imports in goods in country

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[2] Figure 1a in Alfaro and Charlton (2009) indicates that poorer countries have less coverage in terms of affiliates' sales.

[3] Fukui and Lakatos (2012) extrapolate missing values from a gravity regression. Alviarez (2014) complements Eurostat with unpublished OECD data, to assemble a dataset for the activity of affiliates of multinational firms, in terms of revenues and employment, for 35 countries and ten sectors as an average over the 2003–2007 period. One obvious concern is the pervasiveness of missing values: three quarters of the source-host-sector relationships are zeros or missing. While not perfect, the author addresses the problem using ORBIS and BEA data as additional data sources.

[4] Bilateral FDI flows and stocks from the Balance of Payments are also included.

[5] As an alternative extrapolation procedure for affiliate sales, we use (bilateral) Foreign Direct Investment (FDI) stocks from the balance of payment of countries (international investment position), for which the number of missing observations is substantially lower.

[6] The relation between MP volumes and gravity has been largely documented, among others, by Carr, Markusen, and Maskus (2001), who use affiliates' sales; Razin, Rubinstein, and Sadka (2003); and Head and Ries (2008) who use FDI stocks. None of these papers can distinguish between the two margins of MP; the exception is Ramondo (2014).

TABLE 1—GRAVITY: EXTENSIVE AND INTENSIVE MARGINS—TRADE AND MP

Dependent variable	$D(Y_{il})$ (1)	$D(X_{in})$ (2)	$\log \lambda_{in}^T$ (3)	$\log \lambda_{il}^M$ (4)	$\log M_{il}$ (5)	$\log y_{il}$ (6)
log of distance	−0.122*** (0.009)	0.006 (0.005)	−1.082*** (0.034)	−0.917*** (0.051)	−0.767*** (0.042)	−0.119*** (0.033)
Common border	−0.046 (0.035)	−0.007 (0.012)	0.314** (0.134)	0.129 (0.167)	0.23** (0.117)	−0.09 (0.098)
Colonial ties	0.082** (0.035)	0.014** (0.007)	0.70*** (0.128)	0.865*** (0.165)	0.718*** (0.131)	0.139* (0.084)
Common language	0.082*** (0.022)	0.0002 (0.012)	0.407*** (0.086)	0.597*** (0.112)	0.502*** (0.084)	0.110* (0.065)
Observations	3,417	3,417	3,211	1,212	1,202	1,163
R^2	0.82	0.98	0.98	0.98	0.95	0.99

Notes: The operator $D(Z)$ takes the value of one if $Z > 0$ and zero otherwise. Y_{il} denotes revenues of affiliates from i in l, while X_{in} denotes trade flows from i in n. Trade shares are $\lambda_{in}^T \equiv X_{in}/X_n$, while MP shares are $\lambda_{il}^M \equiv Y_{il}/Y_l$. Y_l denotes gross production in nonfinancial sectors, while X_n is expenditure (gross production in nonfinancial sectors minus exports plus imports in goods). M_{il} denotes number of affiliates from i and l, while $y_{il} \equiv Y_{il}/M_{il}$. All regressions include source and destination country fixed effects. Robust standard errors are in parentheses. Levels of significance are denoted.
    ***Significant at the 1 percent level.
    **Significant at the 5 percent level.
    *Significant at the 10 percent level.

n). Table 1 shows the results for gravity for trade and MP using Ordinary Least Squares (OLS). In columns 1 and 2, we estimate a linear probability specification for the extensive margin of trade and MP. In doing so, for MP, we exploit our data that indicate the presence of MP activity from country i in l: the dependent variable in column 1 is a dummy that takes the value of one when we observe a positive or missing value in our data, and zero otherwise. For trade, in column 2, the dependent variable is a similar dummy.[7] Columns 3 to 6 show the results of a log-linear specification for the intensive margins of trade and MP. In column 3, the dependent variable is (in logs) the trade share λ_{in}^T. In column 4, the analogous dependent variable is (in logs) the MP share λ_{il}^M. We further decompose this aggregate MP share into the number of affiliates M_{il} (column 5), and revenues per affiliate $y_{il} \equiv Y_{il}/M_{il}$ (column 6). In all cases, regressors are geographical distance and dummies indicating common border, common language, and colonial ties, from CEPII.

The effects of distance on the country-level extensive margin are large and significant: doubling distance decreases the probability of observing MP activity between two countries by 12 percentage points (column 1). In contrast, we do not find any effect of distance on the extensive margin of trade (column 2). The difference in the results between MP and trade arises because zeros are much more prevalent in MP than trade. Restricting our attention to the countries in our MP dataset, we find that 50 percent of all ordered country pairs have zero MP while only 3 percent have zero trade. It is then not surprising that we find no impact of distance on zeros in bilateral trade flows.[8]

Conditional on observing some MP activity, the effects of distance on MP shares (λ_{il}^M) are rather similar to the ones found for trade shares and close to minus one (−0.91 versus −1.08, respectively). Sharing a border does not have a significant impact on the magnitude of MP, while it has a positive and significant effect on the magnitude of trade. Both sharing a language

[7] For trade, results are unchanged whether we assume that the few missing values are zeros, assume that they are positive missing values, or drop them altogether from the regression.

[8] Helpman, Melitz, and Rubinstein (2008) find an effect of distance on the extensive margin of trade: since their sample of countries is much larger (158), the fraction of country pairs with zero trade is around 50 percent.
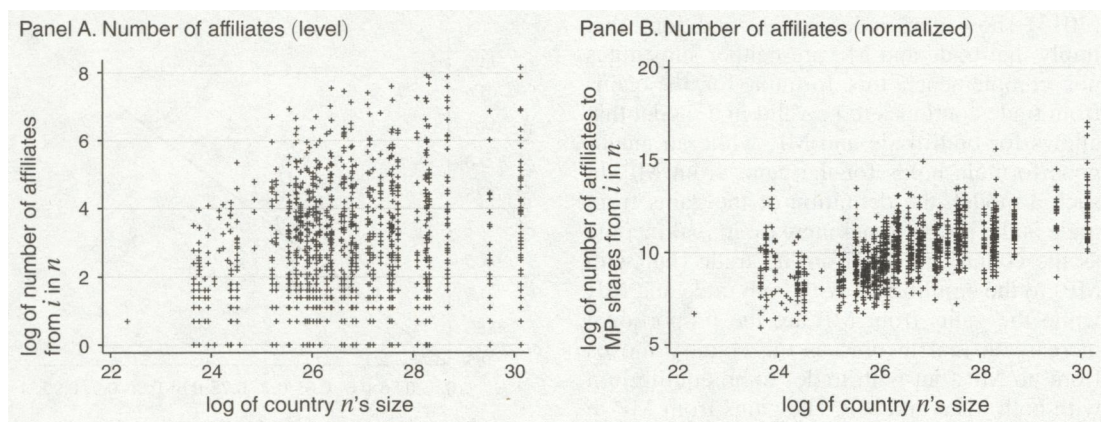
FIGURE 1. MARKET SIZE AND THE EXTENSIVE AND INTENSIVE MARGINS OF MP

Notes: The y-axis is: in panel A, the (log) number of affiliates of firms from country i in l, M_{il}; in panel B, the (log) number of affiliates from i in l, normalized by the MP share, $\lambda_{il}^M \equiv Y_{il}/Y_l$. Market size refers to gross production in nonfinancial sectors, Y_l.

and having colonial ties have a stronger effect on MP than trade shares.

The last two columns in Table 1 decompose the effects of geographical variables on aggregate MP flows into the extensive (number of affiliates M_{il}) and intensive (sales per affiliate, y_{il}) margins, given that we observe some MP activity by country i in l. The extensive margin of MP is much more elastic to changes in each of the covariates included in the regression than the intensive margin: for instance, a 10 percent increase in distance decreases the number of affiliates from i to l by almost 8 percent, while sales per affiliate only decrease by 1.2 percent.

To explore the relative importance of the extensive and intensive margins of MP, we perform an analysis similar to that in Eaton, Kortum, and Kramarz (2011). In Figure 1, panel A we show the bilateral number of affiliates against the size of the receiving market, measured as gross production. As in the analysis in Eaton, Kortum, and Kramarz (2011), for the number of French exporters in each importing country, the relation in Figure 1, panel A is increasing but cloudy. Once we normalize the extensive margin of MP for firms from i in l by the MP share of i in l, the relation becomes tighter: fitting a linear relation in Figure, 1 panel B (with a constant) delivers a coefficient of 0.61 (standard error 0.03), virtually identical to the elasticity reported by Eaton, Kortum, and Kramarz (2011) for French exporters. Including source country

fixed effects brings the size-elasticity down from 0.61 to 0.51.

Figure 1, panel B reveals that the number of MP sellers increases with market size but less than proportionally, meaning that the average sales per seller is also increasing by $1 - 0.61 = 0.39$ (and $1 - 0.51 = 0.49$ when source fixed effects are included). Eaton, Kortum, and Kramarz (2011) had only one source country for exporters, France. Since we have many source countries, we can further see how much of the variation in bilateral MP flows, Y_{il}, is explained by the extensive (M_{il}) and intensive (y_{il}) margins of MP, respectively, controlling for source and host country fixed effects. Results from OLS reveal that: $\log M_{il} = 0.66^{***} \log Y_{il} + S_i + H_l$ (with 1,166 observations and R^2 of 0.98), indicating that two-thirds of the increase in MP flows is through an increase in the number of affiliates, and only a third of the increase comes from the amount of sales per affiliate.

III. Trade and MP Openness

As shown by Arkolakis, Costinot, and Rodríguez-Clare (2012), given a trade elasticity ϵ, a sufficient statistic to compute the gains from trade for a country (i.e., the proportional increase in its real income as it moves from autarky to the trade equilibrium) is its domestic trade share: $GT_l = (\lambda_{ll}^T)^{-\epsilon}$. Ramondo and Rodríguez-Clare

(2013) show that under some conditions that imply that trade and MP are neither substitutes nor complements, this formula for the gains from trade continues to be valid in a model that allows for both trade and MP, while an analogous formula holds for the gains from MP. In such a model, the definition of the gains from trade is the proportional increase in real income as the country moves from no trade (but with MP) to the equilibrium with both trade and MP, while the gains from MP are the proportional increase in real income as the country moves from no MP (but with trade) to an equilibrium with both trade and MP. The gains from MP in this case are given analogously to the gains from trade: $GMP_l = (\lambda_{ll}^M)^{-\epsilon}$.[9] In this particular case of independence of trade and MP, the gains from openness are given by $GO_n = GT_n \cdot GMP_n$.

These results show that domestic trade and MP shares can be used to calculate the gains from openness. It is obvious from Figure 2 that domestic trade and MP shares are positively associated (with a correlation of 0.77). Additionally, roughly half the countries are more open to MP than trade.[10] A good benchmark to compare these two measures of openness is a frictionless world in which domestic trade and MP shares should be the same and equal to the country's share of world output. The United States, for instance, has an MP domestic share of 0.84, and a domestic trade share of 0.93, while their share of world output is 0.30. A small and open economy like Belgium has domestic MP and trade shares of 0.53 and 0.64, respectively, while its share of world output is only 1 percent. These discrepancies are simply an indication of the presence of frictions to the movement of goods and ideas across countries. We can explore more formally the relations among domestic shares, country size, and income, by estimating the following specification with OLS: for trade, $\log \lambda_{ll}^T = -0.29 - 0.076^{**} \log y_l + 0.032^{***} \log X_l$; and for MP, $\log \lambda_{ll}^M = 0.988^{***} - 0.104^{***}$

FIGURE 2. MP AND TRADE DOMESTIC SHARES

Note: Domestic MP (trade) is normalized by gross production (expenditure) in nonfinancial sectors.

$\log y_l - 0.007 \log Y_l$.[11] Both domestic trade and MP shares present an elasticity to real GDP per capita of around -0.1: a country with half the income per capita has domestic shares that are around 10 percent higher, meaning that poorer countries are less open to trade and foreign firms. In turn, domestic trade shares show a size-elasticity of 0.032, indicating that larger countries are less open to trade, while domestic MP shares do not seem to be responsive to country size. In a frictionless world, this coefficient would be one.

As mentioned above, deviations from the frictionless benchmark should be related to trade and MP costs. We explore the magnitude of such costs by applying the approach in Head and Ries (2001), both for trade and MP. Let τ_{ln} be the iceberg trade cost from l to n, and let γ_{il} be an analogous iceberg productivity loss for multinationals from country i that produce in l. Under symmetry (i.e., $\tau_{ln} = \tau_{nl}$ and $\gamma_{il} = \gamma_{li}$) and assuming that there are no domestic trade and MP costs (i.e., $\tau_{ll} = \gamma_{ll} = 1$ for all l), then we can compute trade and MP costs from the observed flows as $\tau_{ln} = \left(\frac{X_{ln} X_{nl}}{X_{nn} X_{ll}}\right)^{-\frac{1}{2\epsilon}}$ and $\gamma_{il} = \left(\frac{Y_{il} Y_{li}}{Y_{ll} Y_{ii}}\right)^{-\frac{1}{2\epsilon}}$. The broad class of trade models

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[9] This formula is also valid for the models with only MP in Burstein and Monge-Naranjo (2009); McGrattan and Prescott (2009); and Ramondo (2014).

[10] Recall that our measure of trade includes all goods, not only in manufacturing, but it does not include trade in services. If we considered only manufacturing trade—normalized by manufacturing expenditure—the US domestic share, for example, would be 0.85, calculated using STAN data, an average over 1996–2001.
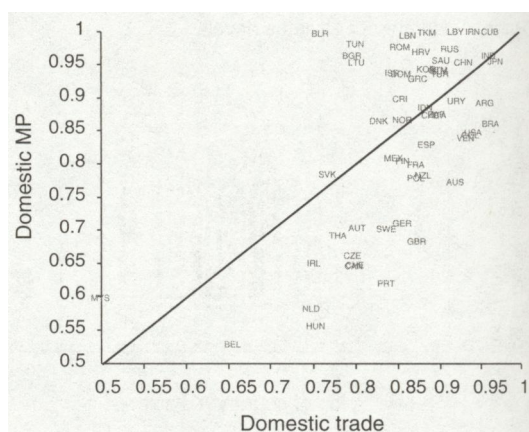
[11] Y_l (X_l) is gross production (expenditure) in nonfinancial sectors, while income per capita is real GDP per capita, PPP-adjusted, from the Penn World Tables 8.1 (PWT).

that satisfy the standard gravity equation satisfy the conditions needed for the validity of the Head-Ries index for trade costs. For MP, we need to restrict the model of trade and MP to the case in which those flows are independent—or to a model with only MP—as shown in Arkolakis et al. (2013).[12] Two remarks are in order. First, the pervasive presence of very low shares of zeros in the bilateral MP data makes it more of a challenge to apply these indices (the class of models for which the Head and Ries index can be applied do not deliver zero flows at the aggregate bilateral level). Nonetheless, we calculate such indices restricting the sample to pairs of countries with positive MP flows both ways. With $\epsilon = 5$, as surveyed by Head and Mayer (2014), the median country pair has an iceberg-type cost of 4.5 for trade, and also for MP. Second, these models abstract from fixed costs of establishing foreign affiliates, which, as shown by Tintelnot (2014), substantially decrease the estimates for iceberg-type MP barriers.

IV. MP, Trade, and the Current Account

Arkolakis et al. (2013) present a trade and MP model that extends the Melitz model by allowing firms to produce outside of their home country. The model implies that foreign subsidiaries earn profits (net of market costs but gross of firm-entry costs) equal to a common share η of their sales, so that profits made by subsidiaries of firms from country i in country l are simply $\Pi\,il = \eta Y\,il$. Of course, these profits are not necessarily repatriated back to the home country, since firms often use those funds for foreign investments or keep them away for tax reasons. But as a matter of accounting, one could use this result to explore how net MP flows may be compensating for trade imbalances. In a model of trade and MP, the current account for country l is given by $CA_l = \left(\sum_{n\neq l} X_{ln} - \sum_{j\neq l} X_{jl}\right) + \eta\left(\sum_{j\neq l}Y_{lj} - \sum_{i\neq l}Y_{il}\right)$. The first term is the trade surplus while the second term is the MP profit surplus. For $\eta = 0.187$, as calibrated by Arkolakis et al. (2013), the United States has a trade deficit of 2.4 percent of GDP that is

partially compensated with a surplus due to MP profits of 0.9 percent: the sum of net trade flows and net MP profits gives a deficit in the current account of 1.5 percent of US GDP, for the late 1990s. The opposite is the case for China: according to our accounting, the current account would have a surplus of 7.4 percent, as a share of GDP, mainly coming from a large trade surplus (8.6 percent of Chinese GDP). The other country that experiences a current account surplus is the Netherlands with a surplus of 21 percent of its GDP coming from a trade surplus of 6 percent and MP profit surplus of 15 percent, both in terms of Dutch GDP. The prediction for Japan is a current account surplus of around 5 percent of its GDP, for the late 1990s, coming from a 2.2 and 2.9 percent surplus in trade and MP profits, respectively.

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[12] Arkolakis et al. (2013) show how to compute the Head-Ries-type index in a set up where trade and MP are not independent.

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