We study product-level data for Taiwanese manufacturing establishments through the lens of a model with variable markups. The model predicts very large welfare gains from trade: moving from autarky to a 10% import share implies an increase in welfare equivalent to a 25% permanent increase in consumption. By contrast, standard trade models imply much smaller gains, around a 2.5% increase in consumption. By increasing competition, trade reduces markups and so reduces distortions in labor and investment choices. Greater competition also induces a more efficient allocation of factors of production across establishments, thereby directly raising TFP. These channels are an order of magnitude more important than the love-of-variety effects in standard trade models. Our model predicts that industries that are more open are characterized by lower (revenue) labor productivity and lower dispersion in labor productivity across producers. We find strong support for these predictions of the model in the Taiwanese data.

*The views expressed herein are those of the authors and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.
1. Introduction

How large are the welfare gains from international trade? We answer this question using a quantitative model with endogenously variable markups. Our main finding is that the welfare gains from trade are large and, in particular, are an order of magnitude larger than those implied by standard models with markups that do not change in response to trade.

In our model, opening an economy to trade exposes domestic firms to a *pro-competitive* mechanism which reduces market shares and increases demand elasticity. As a consequence, firms charge smaller markups over marginal cost. The impact of increased competition on markups leads to gains from trade both by reducing average markups and by reducing dispersion in markups. The former effect directly reduces distortions in labor and investment decisions. The latter effect promotes a more efficient allocation of factors across establishments and so increases total factor productivity (TFP). We quantify the model using product-level data for Taiwanese manufacturing establishments and find that both markup effects are quantitatively substantial. Combined, the model predicts that moving from autarky to a 10% import share implies an increase in welfare equivalent to a 25% permanent increase in consumption. By contrast, a standard trade model that omits to account for the effects of increased competition on markups would predict a 2.5% increase in consumption.

We are far from the first to argue that the pro-competitive effects of trade may increase productivity and welfare. Instead, our main contribution is to carefully *quantify* the pro-competitive mechanism. To conduct this exercise we use a model developed by Atkeson and Burstein (2008). The model features a nested pair of constant elasticity demand systems. Within a country, there is a continuum of imperfectly substitutable industries. Within any given industry, there is a small number of firms who engage in monopolistic competition and whose products are more substitutable for one-another than they are substitutable for products from other industries. The demand elasticity for any given firm depends on both these margins of substitution and on that firm’s market share in its industry. A firm that is a monopolist in its industry faces no competition from close substitutes and so faces a less elastic demand curve than a firm that has a low market share. In this model, the market shares of firms, and hence their demand elasticities and markups, are determined in equilibrium. Heterogeneity in market shares is driven by exogenous firm-level heterogeneity.
in productivity.

We consider a world with two perfectly symmetric countries.\(^1\) A firm in either country can sell into its industry abroad, thereby exposing firms in that industry abroad to more competition, but to do so incurs an iceberg trade cost. Our main interest is the welfare gains from increased exposure to trade that result from reductions in tariffs on importers.\(^2\) For intuition, consider an industry consisting of one large firm that has a high market share and charges a high markup plus a small number of less productive firms that have low market shares and charge low markups. This industry will have a high (revenue-weighted) average markup but also a considerable amount of markup dispersion between the large firm and the small firms. Now imagine confronting this industry with competition from symmetric firms in the same industry abroad. The increased competition will reduce market power across the board, driving down the market share of the large firm (in each country) and thereby increasing demand elasticities and reducing markups. This increase in competition brought about by opening to trade both reduces the average markup and, by shifting the large firms out of the tails of the markup distribution, also reduces dispersion in markups.

To quantify the effect of more competition on markups, we use product-level (7-digit) Taiwanese manufacturing data. We combine this with import data from the WTO to obtain disaggregated import shares for each product category. We use this data to discipline three key factors governing the size of the gains from trade in our model: (i) the equilibrium distribution of firm-level market shares, (ii) the extent to which substitution across industries is a good alternative to substitution within an industry, and (iii) the equilibrium magnitude of the Armington elasticity, i.e., the sensitivity of trade flows to changes in trade costs. In particular, we pin down the parameters governing the firm-level distribution of productivity and fixed costs of operating and exporting by requiring the model to reproduce the distribution of market shares and industry concentration statistics in the Taiwanese data. We choose the elasticity of substitution within industries so that our model matches standard estimates

\(^1\) By considering perfectly symmetric countries — and thus abstracting from aggregate differences in factor endowments or technologies — we isolate the gains from trade that are exclusively due to intraindustry trade, as in Krugman (1979, 1980).

\(^2\) We interpret the trade costs in our model as being essentially technological, at least in the sense of their being difficult to change with policy. Accordingly, we find it more natural to compute the welfare implications of changes in the level of taxes/subsidies on importers.
of the Armington elasticity. We choose the elasticity of substitution between industries so that our model fits the cross-sectional relationship between labor (revenue) productivity and market shares that we observe in the Taiwanese data. All other parameters are assigned values consistent with those used in existing work.

Our model predicts large gains from trade through the effect that increased competition has on the distribution of markups. First, holding fixed a given level of aggregate TFP, increased trade reduces the aggregate markup and so reduces distortions in labor and investment decisions. Second, holding fixed a given level of the aggregate markup, increased trade reduces the dispersion in markups and so endogenously increases the level of aggregate TFP as factors of production are more efficiently allocated. We find that both these effects are large. For example, going from our benchmark economy to the first-best (i.e., eliminating both the level and dispersion in markups) gives a welfare gain equivalent to a 19% permanent rise in consumption. Of this, a 10% welfare gain can be obtained by eliminating the dispersion in markups while leaving the aggregate markup unchanged at its autarkic level. Thus in this case both effects play a roughly equal role in delivering the overall welfare gains.

Increasing TFP by reducing the dispersion in markups is an effect familiar from the work on “misallocation” of factors of production by Restuccia and Rogerson (2008), Hsieh and Klenow (2009) and others. We find that international trade can play a powerful role in reducing misallocation and so increase productivity both at home and abroad. In short, the size of the welfare gains from trade and the extent to which misallocation suppresses the level of TFP are closely related concerns. From a policy point of view, our model suggests that obtaining large welfare gains from an improved allocation may not require the detailed, and perhaps impractical, scheme of cross-subsidies/taxes that implement the first-best. Instead, simply opening an economy to trade may provide an excellent practical alternative that substantially improves welfare even if it does not go all the way to the first-best.

Beginning with Eaton and Kortum (2002) and Melitz (2003), a large recent literature on trade with heterogeneous firms has emphasized two conceptually distinct but related channels by which trade may lead to welfare gains. The first channel is a selection effect. Exposure to trade forces less productive firms to exit and the resulting reallocation of resources increases measured productivity, as in the empirical work of Aw, Chung and Roberts (2000),
Pavcnik (2002) and others. Selection is driven by the need to cover fixed costs of operating and/or exporting. In other words, this channel of reallocation operates at the extensive margin. Without the exit of less productive firms, there would be no increase in aggregate productivity. And as emphasized by Arkolakis, Costinot and Rodríguez-Clare (2011), the quantitative gains from trade in any reasonably calibrated version of a model of this kind are small. The second channel is the pro-competitive effect that we focus on. Reallocation in our model occurs primarily at the intensive margin and there are quantitatively significant gains from trade even if there is no exit by less productive firms. Almost all the gains from trade in our model come from reallocation due to changes in the distribution of markups.

In models such as Melitz (2003), trade has only a selection effect and has no pro-competitive effect because markups are constant. In other trade models, the absence of pro-competitive effects occurs for more subtle reasons. For example, in Bernard, Eaton, Jensen and Kortum (2003) — BEJK hereafter — heterogeneous firms compete in Bertrand fashion to be the sole producer in their industry, and this indeed gives rise to an endogenous markup distribution. The properties of this distribution depend on whether the lowest cost and second-lowest cost firms are domestic or foreign and, in principle, the effects of increased trade depend on how (if at all) trade leads to a new configuration of lowest and second-lowest cost firms. But owing to special properties of the Fréchet distribution, which BEJK use to model firm-level productivity draws, it can be shown that the markup distribution is invariant to a trade liberalization. Increased trade reduces prices but also proportionately reduces costs so that markups are unchanged. Consequently, this analysis misses the effect of trade-induced changes in competition on markups and TFP that are central to our quantitative results.

A pro-competitive effect in a model of monopolistic competition can be obtained by departing from the assumption of a large number of firms facing constant elasticity demand. Atkeson and Burstein (2008) consider monopolistic competition by a small number of firms.

\[3\] In our model, trade acts like the competitive pressure effects surveyed in Holmes and Schmitz (2010).

\[4\] Our model includes fixed costs of operating and exporting and so also features reallocation due to selection, but these effects are quantitatively small. We include fixed costs only to ensure that the model can better match the micro-data we use to determine our key parameters.

\[5\] Of course, departing from the assumption of pure monopolistic competition can also give rise to variable markups that increase with market share. For example, a model of spatial monopolistic competition or models with explicit search frictions can also give this result. For the former, see Anderson, de Palma and Thirsd (1992) for a textbook review. Alessandria (2004) is an example of the latter.
facing constant elasticity demand. Melitz and Ottaviano (2008) consider monopolistic competition by a large number of firms that face linear demand curves and hence a variable elasticity of demand. Both of these frameworks predict that more productive firms will have larger market shares and charge larger markups. In both frameworks, an increase in international trade has the effect of increasing competition and reducing markups. Other departures from constant elasticity demand, such as the translog demand systems considered by Feenstra and Weinstein (2010) and Novy (2010) can give similar effects. In addition to its theoretical appeal, this pro-competitive effect is widely documented in empirical work. Examples from the trade literature include Harrison (1994), Levinsoln (1993) and Bottasso and Sembenelli (2001). Campbell and Hopenhayn (2005) document a similar effect in U.S. establishment data. Relative to this empirical work, our main contribution is to embed the pro-competitive mechanism in a tightly grounded model that can be used for welfare analysis and counterfactual experiments.

Several recent theoretical papers on variable markups also highlight the importance of changes in markup dispersion for aggregate productivity and the gains from trade. Epifani and Garcia (2011) provide conditions under which falls in markup dispersion increase aggregate productivity, but in their analysis the markup distribution is exogenous. Peters (2011) provides a related analysis of a closed-economy model where the markup distribution is endogenous because of entry/exit decisions by firms and discusses the implications of the markup distribution for aggregate productivity. Like us, he emphasizes that only the aggregate markup matters for factor prices, and hence for labor and investment decisions, and that it is markup dispersion that inefficiently reduces aggregate productivity. De Blass and Russ (2010) have extended BEJK so that the distribution of markups is endogenous to trade costs. Holmes, Hsu and Lee (2011) make a related theoretical contribution and construct a model that nests both a standard constant elasticity framework and BEJK framework as special cases. Though they differ in details, both Holmes et al (2011) and de Blass and Russ (2010)

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6 In Dixit and Stiglitz (1977), if there is a small number of homogeneous producers the markup is endogenous to the number of producers — but the distribution of market shares is uniform. Atkeson and Burstein (2008) enrich this model by considering firm-level heterogeneity in productivity which then determines, in equilibrium, the distribution of market shares.

7 Arkolakis et al (2010) show, however, that if firm-level productivity has a Pareto distribution then the translog demand system will still give small gains from trade.
have a selection effect and a pro-competitive effect and both can account, qualitatively, for a trade-induced fall in markup dispersion and the resulting increase in productivity. Relative to these papers, our main contribution is quantifying the pro-competitive mechanism.

To further evaluate the pro-competitive mechanism, we examine several other predictions of the model. For example, the model predicts that industries with higher import shares are more competitive and have both lower levels of measured labor (revenue) productivity and lower dispersion in labor productivity. Encouragingly for our mechanism, we find strong support for both predictions in the Taiwanese data. If we divide our industries into two subgroups, those with relatively high import shares and those with low import shares, then we find that high import share industries have measured labor productivity that is some 6-10% lower than that of low import share industries. Similarly, if we look at dispersion in measured labor productivity, we find that high import share industries have less dispersed labor productivity than low import share industries. Moreover, we find that most of the reduction in dispersion comes from reducing the labor productivity of the largest firms. This is consistent with the model’s prediction that most of the reduction in markup dispersion comes from exposing large firms to more effective competition.

The remainder of the paper proceeds as follows. Section 2 presents the model and shows how the distribution of markups, aggregate TFP and the Armington elasticity are determined in equilibrium. Section 3 gives an overview of the Taiwanese manufacturing data and Section 4 explains how we use that data to quantify the model. Section 5 contains our main results on the welfare gains from international trade. Section 6 provides evidence showing that our model’s predictions for the cross-industry relationship between import shares and the distribution of labor productivity are supported by the Taiwanese data. Section 7 concludes.

2. Model

The world consists of two symmetric countries, Home and Foreign. We focus on describing the problem of agents in Home in detail. The Foreign agents’ problems are similar. We indicate Foreign variables with an asterisk.
A. Consumers

The problem of Home consumers is to choose consumption $C_t$, labor supply $L_t$, investment in physical capital $X_t$, and holdings of bonds $B_{t+1}$ to:

$$\max_{c_t, l_t, x_t, b_{t+1}} \sum_{t=0}^{\infty} \beta^t U (c_t, l_t)$$

subject to:

$$P_t (C_t + X_t) + Q_t B_{t+1} \leq W_t L_t + D_t + B_t + R_t K_t$$

where $P_t$ is the price of the final good, $Q_t$ is the price of a bond, $W_t$ is the wage rate, $D_t$ are firm dividends, and $R_t$ is the rental rate of physical capital, $K_t$, which follows the law of motion:

$$K_{t+1} = (1 - \delta) K_t + X_t$$

The solution to the Home consumers’ problem is characterized by the standard first order conditions:

$$\frac{U_{l,t}}{U_{c,t}} = \frac{W_t}{P_t}$$

$$\frac{Q_t U_{c,t}}{P_t} = \beta \frac{U_{c,t+1}}{P_{t+1}}$$

$$U_{c,t} = \beta U_{c,t+1} \left( \frac{R_{t+1}}{P_{t+1}} + (1 - \delta) \right)$$

We assume identical initial capital stocks, initial bond holdings and technologies in the two countries. Absent aggregate uncertainty, this implies that trade is balanced in each period, and, in addition, that:

$$\frac{P_t^*}{P_t} = \frac{U_{c,t}^*}{U_{c,t}}$$
B. Intermediate Goods Producers

Intermediate goods producers are organized in a measure \( j \in [0, 1] \). An individual producer \( i \) operating in industry \( j \) uses the technology:

\[
y_{i,j,t} = a_{i,j} k_{i,j,t}^{\alpha} l_{i,j,t}^{1-\alpha}
\]

where \( a_{i,j} \) is the producer’s idiosyncratic productivity, which we assume is time-invariant, \( k_{i,j,t} \) is the amount of capital hired by the producer, and \( l_{i,j,t} \) is the amount of labor hired. We discuss the assumptions we make on the distribution of firm-level productivity \( a_{i,j} \) in Section 4 below.

An intermediate goods producer sells output to final goods producers located in both countries. Let \( y_{i,j,t}^{H} \) be the amount sold to Home final goods producers and similarly let \( y_{i,j,t}^{*H} \) be the amount sold to Foreign final goods producers. The resource constraint for Home intermediates is:

\[
y_{i,j,t} = y_{i,j,t}^{H} + (1 + \tau)y_{i,j,t}^{*H}
\]

where \( \tau > 0 \) is an iceberg trade cost, i.e., a total of \((1 + \tau)y_{i,j,t}^{*H}\) must be shipped from Foreign for \( y_{i,j,t}^{*H} \) to arrive in the Home country.

We describe an intermediate goods producer’s problem below, after describing the demand for their good. Due to fixed costs of operating, not all intermediate firms will be selling. Let the indicator function \( \phi_{i,j,t}^{H} \in \{0, 1\} \) denote the decision to operate or not in the home market and let \( \phi_{i,j,t}^{F} \in \{0, 1\} \) denote the decision to operate in the foreign market.

Foreign intermediate goods producers face an identical problem. We let \( y_{i,j,t}^{*} \) denote their output and note that the resource constraint for Foreign intermediates is:

\[
y_{i,j,t}^{*} = (1 + \tau)y_{i,j,t}^{F} + y_{i,j,t}^{*F}
\]

where \( y_{i,j,t}^{*F} \) is the amount sold to Foreign final goods producers and \( y_{i,j,t}^{F} \) is the amount shipped to Home final goods producers.
C. Final Good Producers

The producers of the final good are perfectly competitive. Consider first the problem of firms that operate in Home. These firms buy a continuum of intermediate goods at prices $P_{i,j,t}^H$ and $P_{i,j,t}^F$, and sell a final good to consumers at price $P_t$. The technology with which final goods producers operate is:

$$Y_t = \left( \int_0^1 \frac{y^t_{j,t}}{y^t_{j,t}} \, dj \right)^{\frac{\theta}{\gamma - 1}}$$

where $\theta > 1$ is the elasticity of substitution across industries $j$ and where industry output $y_{j,t}$ is given by:

$$y_{j,t} = \left( \frac{1}{N} \sum_{i=1}^{N} \left( \phi_{i,j,t}^H y_{i,j,t}^H \right)^{\gamma - 1} + \frac{1}{N} \sum_{i=1}^{N} \left( \phi_{i,j,t}^F y_{i,j,t}^F \right)^{\gamma - 1} \right)^{\frac{1}{\gamma - 1}}$$

where $\gamma > \theta$ is the elasticity of substitution across goods $i$ within a particular industry $j$.

The problem of a final goods producer is to:

$$\max_{y_{i,j,t}^H, y_{i,j,t}^F} \left[ P_t Y_t - \int_0^1 \left( \frac{1}{N} \sum_{i=1}^{N} \phi_{i,j,t}^H P_{i,j,t}^H y_{i,j,t}^H + (1 + \tau) \frac{1}{N} \sum_{i=1}^{N} \phi_{i,j,t}^F P_{i,j,t}^F y_{i,j,t}^F \right) \, dj \right]$$

The optimal choices of $y_{i,j,t}^H$ and $y_{i,j,t}^F$ are therefore:

$$y_{i,j,t}^H = \left( \frac{P_{i,j,t}^H}{P_{j,t}} \right)^{-\gamma} \left( \frac{P_{i,t}}{P_t} \right)^{-\theta} Y_t$$

and

$$y_{i,j,t}^F = \left( \frac{(1 + \tau) P_{i,j,t}^F}{P_{j,t}} \right)^{-\gamma} \left( \frac{P_{j,t}}{P_t} \right)^{-\theta} Y_t$$

where the aggregate and industry price indexes are:

$$P_t = \left( \int_0^1 \frac{1}{P_{j,t}^{1-\theta}} \, dj \right)^{\frac{1}{\theta}}$$
and

\[
D_{i,j,t}^H = \max_{y_{i,j,t}^H, k_{i,j,t}^H, l_{i,j,t}^H} \left[ P_{i,j,t}^H y_{i,j,t}^H - R_t k_{i,j,t}^H - W_t l_{i,j,t}^H \right]
\]

The choice of labor and capital satisfy the standard first order conditions:

\[
\begin{align*}
\alpha V_{i,j,t} \frac{y_{i,j,t}^H}{k_{i,j,t}^H} &= R_t \\
(1 - \alpha) V_{i,j,t} \frac{y_{i,j,t}^H}{l_{i,j,t}^H} &= W_t 
\end{align*}
\]
where \( V_{i,j,t} \) is marginal cost (which, by symmetry, is common to both the domestic and export market), and is given by:

\[
V_{i,j,t} = \frac{\alpha^{-\alpha} (1 - \alpha)^{-(1-\alpha)} P_{i,j}^{H} W_{i,t}^{1-\alpha}}{a_{i,j}} = \frac{V_{t}}{a_{i,j}}
\]

where we define the “aggregate” marginal cost \( V_{t} \) by:

\[
V_{t} = \alpha^{-\alpha} (1 - \alpha)^{-(1-\alpha)} R_{t}^{a} W_{t}^{1-\alpha}
\]

Using this, we can also write the profits of the intermediate producer as:

\[
D_{i,j,t}^{H} = \max_{y_{i,j,t}^{H}} \left[ \left( P_{i,j,t}^{H} - \frac{V_{t}}{a_{i,j}} \right) y_{i,j,t}^{H} \right]
\]

subject to the demand function (2) above.

As usual, the solution to this problem is characterized by a price that is a markup over marginal cost:

\[
P_{i,j,t}^{H} = \frac{\varepsilon_{i,j,t}^{H}}{\varepsilon_{i,j,t}^{H} - 1 a_{i,j}} \frac{V_{t}}{a_{i,j}}
\]

where \( \varepsilon_{i,j,t}^{H} \) is the demand elasticity in the Home market, which satisfies:

\[
(6) \quad \varepsilon_{i,j,t}^{H} = \left( \omega_{i,j,t}^{H} \frac{1}{\theta} + (1 - \omega_{i,j,t}^{H}) \frac{1}{\gamma} \right)^{-1}
\]

where \( \omega_{i,j,t}^{H} \) is the market share of producer \( i \) in industry \( j \) in the Home market:

\[
(7) \quad \omega_{i,j,t}^{H} = \frac{P_{i,j,t}^{H} y_{i,j,t}^{H}}{\sum_{i=1}^{N} \phi_{i,j,t}^{H} P_{i,j,t}^{H} y_{i,j,t}^{H} + (1 + \tau) \sum_{i=1}^{N} \phi_{i,j,t}^{F} P_{i,j,t}^{F} y_{i,j,t}^{F}} = \frac{1}{N} \left( \frac{P_{i,j,t}^{H}}{P_{j,t}^{H}} \right)^{1-\gamma}
\]

As in Atkeson and Burstein (2008), the demand elasticity in the Home market is endogenous and is given by a weighted harmonic average of the between-industry elasticity of substitution \( \theta \) and the within-industry elasticity of substitution \( \gamma > \theta \). Firms that have a higher share of an industry’s revenue will face an endogenously lower demand elasticity and hence charge
higher markups. In effect, these firms compete more with producers in other industries and so face a demand elasticity closer to $\theta$ than they compete with other smaller producers in their own industry. Quantitatively, the extent to which markups vary across firms depends both on the (endogenous) dispersion in market shares within industries and on the size of the difference between the two underlying elasticities, $\gamma$ and $\theta$. If, for example, $\gamma$ and $\theta$ are approximately the same, then the demand elasticity will also approximately equal that common value irrespective of the dispersion in market shares. Alternatively, if $\gamma$ is substantially larger than $\theta$, then the demand elasticity is very convex and a modest change in market shares can have a large effect on demand elasticity.

**E. Entry and Exit**

Each period a firm must pay a fixed cost $F_d$ to sell in its home market. The firm sells in the Home market as long as:

$$D_{i,j,t}^H - F_d W_t \geq 0$$

Similarly, the firm must pay another fixed cost $F_f$ to operate in its foreign market. The firm exports as long as:

$$D_{i,j,t}^{*H} - F_f W_t \geq 0$$

There are multiple equilibria in any given industry. Different combinations of intermediate firms may choose to operate, given that the others do not. As in Atkeson and Burstein (2008), we place intermediate firms in the order of their productivity $a_{i,j}$ and focus on equilibria in which firms sequentially decide on whether to operate or not: the most productive decides first (given no other firm enters), the second most productive decides second (given that no other less productive firm enters), etc.
F. Equilibrium

In equilibrium, consumers and firms optimize and the markets for labor and physical capital clear:

\[ L_t = \int_0^1 \frac{1}{N} \sum_{i=1}^N \left[ (l^H_{i,j,t} + F_d) \phi^H_{i,j,t} + (l^*_H_{i,j,t} + F_f) \phi^*_H_{i,j,t} \right] dj \]

\[ K_{t-1} = \int_0^1 \frac{1}{N} \sum_{i=1}^N \left[ k^H_{i,j,t} \phi^H_{i,j,t} + k^*_H_{i,j,t} \phi^*_H_{i,j,t} \right] dj \]

(here we present the Home market clearing conditions, the Foreign conditions are identical).

The market clearing condition for the final good in each country is:

\[ Y_t = C_t + X_t \]

Recall that we assume zero initial bond holdings for each country, so that due to symmetry and the lack of aggregate uncertainty, trade is balanced in each period.

G. Markups and TFP

We next describe qualitatively the determinants of the aggregate level of markups and TFP. Straightforward algebra shows that the quantity of final output in each economy is given by:

\[ Y = AK^{\alpha} \tilde{L}^{1-\alpha} \]

where \( K \) is the aggregate stock of physical capital owned by the household, and \( \tilde{L} \) is the aggregate amount of labor used net of fixed costs. The aggregate level of TFP is related to industry-level productivity according to:

\[ A = \left( \int_0^1 \left( \frac{m_j}{m} \right)^{-\theta} A_j^{q-1} dj \right)^{\frac{1}{q-1}} \]
where industry productivity $A_j$ can be written:

$$A_j = \left( \frac{1}{N} \sum_{i=1}^{N} \phi_{i,j}^H \left( \frac{m_{i,j}^H}{m_j} \right)^{-\gamma} a_{i,j}^{-1} + (1 + \tau)^{1-\gamma} \frac{1}{N} \sum_{i=1}^{N} \phi_{i,j}^P \left( \frac{m_{i,j}^P}{m_j} \right)^{-\gamma} a_{i,j}^{-1} \right)^{\frac{1}{1-\gamma}}$$

and where $m_j$ is the markup in that industry, defined by:

$$m_j = \frac{P_j}{V/A_j}$$

while $m = \frac{P}{V/A}$ is the corresponding aggregate markup. Industry productivity $A_j$ is defined implicitly by:

$$y_j = A_j k_j^\alpha l_j^{1-\alpha}$$

where industry output $y_j$ is defined in (1) and where $k_j = \frac{1}{N} \sum_{i=1}^{N} k_{i,j}$ and $l_j = \frac{1}{N} \sum_{i=1}^{N} l_{i,j}$ are the amounts of physical capital and labor used by industry $j$.

The aggregate markup $m$ can be written as a weighted harmonic average of producer-level markups:

$$m = \frac{1}{N} \sum_{i=1}^{N} \phi_{i,j}^H \frac{1}{m_{i,j}^H} p_{i,j}^H y_{i,j}^H + (1 + \tau) \frac{1}{N} \sum_{i=1}^{N} \phi_{i,j}^P \frac{1}{m_{i,j}^P} p_{i,j}^P y_{i,j}^P$$

with weights given by each firm’s share of aggregate revenue.

The presence of market power provides two conceptually distinct channels by which equilibrium allocations are distorted relative to an efficient level. First, the aggregate markup $m > 1$ distorts aggregate labor and investment choices. Using the first order conditions for the consumers’ problem and the expressions for labor and capital demand above, these can be written:

$$-\frac{U_{l,t}}{U_{c,t}} = \frac{W_t}{P_t} = \frac{1}{m_t} (1 - \alpha) \frac{Y_t}{L_t}$$
and
\[ U_c,t = \beta U_{c,t+1} \left( \frac{R_{t+1}}{P_{t+1}} + (1 - \delta) \right) = \beta U_{c,t+1} \left( \frac{1}{m_{t+1}} \frac{Y_{t+1}}{K_{t+1}} + (1 - \delta) \right) \]

High aggregate markups thus act like distortionary labor and capital income taxes and reduce output relative to its efficient level. Second, from (8) and (9), we see that dispersion in markups endogenously reduces the level of aggregate TFP, as in the work of Restuccia and Rogerson (2008) and Hsieh and Klenow (2009). Worse, since markups and productivity (output) are positively correlated, those firms with high productivity that should be employing a greater share of the economy’s stock of capital and labor are exactly those that fail to do so.

H. Armington Elasticity

In standard trade models, a key statistic governing the gains from trade is the Armington elasticity. The Armington elasticity is defined as the partial elasticity of trade flows to changes in trade costs, and in particular,

\[ 1 - \sigma = -\frac{\partial \log \frac{1 - \lambda}{\lambda}}{\partial \tau} \]

where \(\lambda\) is the share of spending on domestically produced goods. In our model \(\lambda\) is:

\[ \lambda = \frac{\int_0^1 \frac{1}{N} \sum_{i=1}^N \phi_{i,j}^H P_{i,j}^H y_{i,j}^H dj}{\int_0^1 \left( \frac{1}{N} \sum_{i=1}^N \phi_{i,j}^H P_{i,j}^H y_{i,j}^H + (1 + \tau) \frac{1}{N} \sum_{i=1}^N \phi_{i,j}^F P_{i,j}^F y_{i,j}^F \right) dj} = \int_0^1 \lambda_j \left( \frac{P_j}{P} \right)^{1-\theta} dj = \int_0^1 \lambda_j s_j dj \]

where the \(\lambda_j\) are industry-level shares of spending on domestically produced goods and where \(s_j\) is each industry’s share in total spending.

Some algebra shows that the Armington elasticity is related to the two key underlying elasticity of substitution parameters \(\gamma\) and \(\theta\), according to the weighted average:

\[ \sigma = \gamma \left( \int_0^1 s_j \frac{\lambda_j}{\lambda} \frac{1 - \lambda_j}{1 - \lambda} dj \right) + \theta \left( 1 - \int_0^1 s_j \frac{\lambda_j}{\lambda} \frac{1 - \lambda_j}{1 - \lambda} dj \right) \]

To understand this expression, note that a reduction in trade costs in this model changes import shares through two channels: (i) by increasing the import shares in each industry \(j\),
an effect governed by the within-industry elasticity $\gamma$, and (ii) by reallocating expenditure towards industries with lower import shares, an effect governed by the between-industry elasticity $\theta$. The weight on the within-industry elasticity $\gamma$ is a measure of the dispersion in industry-level import shares. For example, if all industries have identical import shares $\lambda_j = \lambda$ for all $j$, then changes in trade costs imply no between-industry reallocation of resources and $\sigma = \gamma$. In this case, all the effects from a reduction in trade costs come through channel (i), i.e., through a uniform increase in import shares. At the other extreme, if some industries have import shares of $\lambda_j = 0$ while all others have import shares of $\lambda_j = 1$, then changes in trade costs imply that all reallocation is between industries and $\sigma = \theta$. In this case, all the effects from a reduction in trade costs come through channel (ii), i.e., by reallocation towards industries with low import shares. More generally, the Armington elasticity depends on the dispersion in import shares across industries.

3. Data

The data we use is from the Taiwan Annual Manufacturing Survey conducted by the Ministry of Economic Affairs of Taiwan. The survey’s purpose is to record the opening, relocation, and closing of manufacturing plants. It reports data for the universe of establishments which engage in production activities. Our sample covers the years 2000 and 2002–2004. The year 2001 is missing because in that year a separate census was conducted.

The dataset we use has two parts. First, a plant-level part collects detailed information on operations, such as employment, expenditure on labor, materials and energy, and total revenue. Second, a product-level part collects further information on revenues for each of the products produced at a given plant. Each product is categorized into a 7-digit Standard Industrial Classification created by the Taiwanese Statistical Bureau. This classification at 7 digits is comparable to the detailed 5-digit SIC product definition collected for U.S. manufacturing plants as described by Bernard, Redding and Schott (2010). Panel A of Table 0 gives an example of this classification, while Panel B of Table 0 reports the distribution of 7-digit products and 4-digit industries within 2-digit sectors. Most of the products are

---

8The survey is however a sub-sample of the manufacturing census, because it excludes any plants which do not engage in production activities and only participate in sales.
concentrated in the Chemical Materials, Industrial Machinery, Computer/Electronics and Electrical Machinery industries.

We supplement the survey with detailed import data at the HS-6 product level. We obtain the import data from the WTO and then match HS6 codes with the 7-digit product codes used in the Survey of Manufacturing. This match gives us disaggregated import penetration ratios for each product category.

4. Quantification

We use the Taiwanese data to pin down the key parameters of our model and then quantify the welfare gains from international trade. In the model, three key factors determine the size of the gains from trade: (i) the equilibrium distribution of firm-level market shares, (ii) the size of the gap between $\gamma$ and $\theta$ which governs the impact that the distribution of market shares has on markups, and (iii) the equilibrium magnitude of the Armington elasticity. We pin down the parameters governing the distribution of firm-level market shares — namely, the distribution of firm-level productivity and the size of the fixed costs — by requiring the model to match the distribution of market shares and industry concentration statistics in our product-level data. We choose the elasticity of substitution within industries, $\gamma$, to match standard estimates of the Armington elasticity used in the trade literature. We choose the elasticity of substitution between industries, $\theta$, so that our model reproduces the relationship between labor (revenue) productivity and market shares we observe in the product-level data. We assign values to the rest of the parameters consistent with those used in existing work.

The period length is one year. We assume a time discount factor of $\beta = 0.96$ and a capital depreciation rate of $\delta = 0.10$. The elasticity of output with respect to physical capital is $\alpha = 1/3$. Because of the markups, this does not correspond to capital’s share in aggregate income. We assume a utility function:

$$U(C, L) = \log C + \psi \log (1 - L)$$

We choose a value for $\psi$ to ensure $L = 0.3$ in the steady-state, implying a Frisch elasticity of labor supply equal to 2.33, in line with the findings of Rogerson and Wallenius (2009).

The parameters we calibrate are the elasticity of substitution within industries $\gamma$, the
fixed cost of selling in the domestic and foreign markets, \( F_d \) and \( F_f \), the number of potential producers within a sector \( N \), the size of the iceberg trade cost \( \tau \), as well as the parameters governing the distribution of productivity across products. We assume that productivity \( a \) is distributed according to:

\[
a \sim \begin{cases} 
\frac{1-a^{-\mu}}{1-H^{-\mu}} & \text{with prob. } 1-p_H \\
H & \text{with prob. } p_H
\end{cases}
\]

That is, a fraction \((1 - p_H)\) of firms draw \( a \) from a bounded Pareto on \([1, H]\) with shape parameter \( \mu \) and the remaining \( p_H \) firms have productivity exactly \( H \). We found that imposing a mass-point at the upper bound is critical in allowing the model to match the high concentration in market shares we document below in the data.

Table 1 summarizes our parameterization. Panel A reports the moments we use to pin down our parameter values, both in the data and in the model. Panel B reports the parameter values that achieve this fit. Panel A first shows that there is an average of 26 domestic producers operating in any 7-digit industry (28 in the model). The mean and median inverse Herfindhals (among domestic producers) in an industry are 7.3 and 4.0 in the data (5.6 and 4.6 in the model). Recall that the inverse Herfindhal would be equal to the number of producers in an industry if all those producers had equal market shares. In other words, although there are 26 producers in any industry, only some 4 to 7 of those account for the bulk of an industry’s revenues. We also find very large concentration among domestic producers: the largest 7-digit producer accounts for an average of 40-45% of that product’s domestic sales (38-49% in the model).

The next few rows of Panel A of Table 1 report the distribution of market shares across domestic producers. Unlike the previous statistics, these now reflect sales by both domestic producers and imports. The average market share of a domestic producer is 2.9% in the data (2.8% in the model), while the median firm has a share of slightly below 0.5% in both the model and the data. The distribution of shares is heavily fat-tailed: the 95th percentile of this distribution is about 14% and the 99th percentile is about 46% in both model and data. The pattern that emerges is thus one of very strong concentration. Although many producers operate in any given industry, most of them are small and a few large producers account for
the bulk of an industry’s revenue.

The next few rows of Panel A of Table 1 show that imports account for 22% of all revenue in this industry, 25% of producers export to foreign destinations, and that the elasticity of labor productivity with respect to a producer’s market share \( \omega_i \) is equal to 0.08 in the model (0.07 in the data). Doubling a firm’s market share raises its labor productivity by about 8%. These last three statistics are key in determining values for the iceberg trade cost \( \tau \), the fixed cost of exporting \( F_I \), and the fixed cost of selling domestically \( F_d \). Since the fixed costs are a smaller share of the wage bill for larger producers, the relationship between labor productivity (inclusive of fixed costs) and firm size pins down the size of the fixed costs.

Finally, we choose \( \gamma = 8.5 \) in order for the model to reproduce an Armington elasticity of \( 1 - \sigma = -0.7 \), a typical number used in trade studies. We set the elasticity of substitution across industries to \( \theta = 1.25 \) so that our model reproduces the relationship between labor productivity and market shares that we observe in the product-level data. Compared to existing work, \( \theta = 1.25 \) allows for considerably more substitution across industries. For example, Atkeson and Burstein (2008) use \( \theta = 1.01 \) so that industry-level expenditure shares are nearly constant. There is a large gap between \( \gamma = 8.5 \) and \( \theta = 1.25 \), so the model implies a very convex relationship between markups and market shares, as illustrated in Figure 1.

Table 2 reports several additional micro-implications of the model. We note that the model implies a mean markup of 1.17, a median markup of 1.14 and a rather small standard deviation of markups across producers, of 0.11. But as is clear from equation (10) above, what really matters for the model’s aggregate implications are the revenue-weighted markups and markup dispersion. And indeed, the large producers in the model do have very high markups: the 95th percentile markup is 1.27, while the 99th percentile is 1.76.

Our model also has implications for the dispersion in the share of labor in value-added, since the labor share (excluding the fixed costs) is inversely proportional to markups. Once again, the model produces very little such dispersion compared to the data (0.05 vs. 0.64 in the data). Moreover, labor productivity is much less sensitive to producer size in the

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9See for example Broda and Weinstein (2006) or Feenstra, Obstfeld and Russ (2010). For a broad overview, see Anderson and van Wincoop (2004).

10We find that 4-digit industry dummies account for only 1/10th of the cross-section variation in labor shares, suggesting that most variation is within, rather than across industries.
model (an elasticity of labor productivity to revenue of 0.07) than it is in the data (0.20). But again, what really matters for the model’s aggregate implications is revenue-weighted labor productivity. Revenue-weighted labor productivity is much more sensitive, since, in the model, a few large producers have high markups and high labor productivity. To see this, notice that the aggregate labor share \( \frac{w^L}{PY} = \frac{1-\alpha}{m} \) is equal to 0.46, and thus is much lower than the mean labor share of 0.62. The aggregate markup is therefore much greater than the mean markup. The aggregate labor share in the data is 0.24 and so is much smaller than that produced by our model. Consequently, the model accounts for only about 30% of the gap between the average and aggregate markup in the data, that is \( \frac{\log(0.46/0.62)}{\log(0.24/0.62)} = 0.31 \).

5. Welfare Gains from Trade

We proceed first by discussing the efficiency losses due to markups in our economy. We then study how trade subsidies or tariffs affect the extent of these losses and compute the welfare gains from international trade.

A. Efficiency Losses in the Benchmark Model

We quantify the efficiency losses from markups in our Benchmark economy calibrated to the Taiwanese manufacturing data. To do so, we use the following policy experiment. We subsidize/tax each producer in the economy in order to induce them to charge the same markup. We assume that such subsidies are financed via lump-sum taxes levied on consumers and hence can fully restore efficiency.

Let \( \bar{m} \) be the markup that this policy is designed to implement. We choose producer-specific subsidies/taxes, \( \tau_{i,j} \), to ensure that each producer charges a markup equal to \( \bar{m} \). That is, we choose \( \tau_{i,j} \) to ensure that the solution to the producer’s problem,

\[
\max_{y_{i,j}} \left[ \left( 1 + \tau_{i,j} \right) P_{i,j}^H - \frac{V}{a_{i,j}} \right] y_{i,j}
\]

subject to the demand function (2), implies a choice of prices equal to:

\[
P_{i,j}^H = \bar{m} \frac{V}{a_{i,j}}
\]
That is, we choose:
\[
\tau_{i,j} = \frac{\varepsilon_{i,j}^H}{\varepsilon_{i,j}^H - 1 \bar{m}} - 1
\]

where the demand elasticity \(\varepsilon_{i,j}^H\) satisfies the formula given in equation (6) above but is now determined by the market shares under the new policy.

We consider two experiments that are reported in Table 3. In the first, labeled First Best, we set \(\bar{m} = 1\) and so eliminate both the dispersion and the level of markups. In the second experiment, we set \(\bar{m} = 1.45\), thus eliminating all the markup dispersion but keeping the aggregate markup unchanged from its Benchmark value. In all our experiments we compute statistics inclusive of the transition path from the initial steady state to the final steady state. The welfare numbers including the transition path are smaller than would be obtained from a static comparison across steady states. There are two reasons for this. Along the transition path consumers both forgo consumption to invest in physical capital and, in addition, employment temporarily overshoots its new steady state level.

That said, Table 3 shows that the efficiency losses due to markups are large. Eliminating markups altogether leads to welfare gains equivalent to a permanent 19% increase in consumption.\textsuperscript{11} This increase in welfare is due to a 7% increase in TFP and due to the fact that employment increases by 30%, leading to a 59% increase in output.

The last column of Table 3 shows that eliminating markup dispersion alone would generate significant welfare gains (equivalent to a 10% permanent increase in consumption) due to the 7% increase in TFP.

\textbf{B. Efficiency Losses in Autarky}

How does trade affect the efficiency losses from markups and misallocation? To see this, consider a perturbation of our model in which we impose import tariffs that make trade prohibitively expensive in both countries and thus reduce the import share from 22% in the Benchmark model to zero. The italicized entries in Table 3 show that, absent trade, domestic

\textsuperscript{11}To get a sense of the importance of including the transition path, the welfare gains would be equivalent to a 30% permanent increase in consumption, rather than 19%, if we only made a comparison across steady states.
firms would charge somewhat greater markups: the aggregate markup would increase from 1.45 to 1.69. Moreover, the dispersion in markups would greatly increase as well.

The column labeled First Best shows that eliminating markups altogether would lead to welfare gains of about 49%. Again, eliminating markup dispersion alone would generate significant welfare gains (32%) due to the 23% increase in TFP that results from reallocating factors of production efficiently across producers.

In summary, trade in this model is a powerful mechanism that reduces the extent of misallocation of factors of production and distortions to investment and employment decisions. Opening to international trade is a simple way for an economy to reap the majority of the gains from an improved allocation of factors. In this sense, merely opening an economy to trade provides an excellent substitute for the complicated scheme of product-specific subsidies \( \tau_{i,j} \) that, for a host of technical, administrative and political economy reasons, would surely be difficult to implement in practice. Moving from autarky to the level of trade observed in Taiwan reduces the TFP losses from misallocation by more than 2/3, from 23% to 7%.

The mechanism through which trade increases efficiency and lowers markups is straightforward, and can be seen in the expressions for the demand elasticity and market shares in (6) and (7). An increase in import shares lowers the market shares of individual producers and therefore raises their demand elasticity (i.e., there is more competition within an industry) and reduces markups. Recall that the relationship between markups and market shares is highly convex, as in Figure 1, so even small increases in import shares, generate a decrease in the market shares of the largest producers and therefore substantially lower their markups, thus increasing TFP as more resources are allocated to the highest-productivity producers.

Figure 1 also illustrates this insight, showing how the distribution of shares changes as we move from autarky to free trade (we report the share of output accounted for by firms with shares between 0 and 0.1, 0.1 and 0.2 etc). Under autarky, about 10% of the output is accounted for by producers that have a market share greater than 0.9 and hence are effectively monopolists in their industry. Reducing tariffs exposes these firms to more competition and lowers their market shares to about 60% forcing them to halve their markups.
C. Measuring the Gains from Trade

We next explore the welfare gains from trade in more detail, and show how allocations and efficiency change as we change the tariffs levied on importers from complete autarky to subsidies on imports that increase the import share to 40%. To illustrate how the gains from trade depend on the micro details in the data, we also compute similar statistics for a standard economy with $\theta = \gamma$ and hence no markup dispersion.

Figure 2 shows the relationship between import shares and the welfare gains from trade as we vary the subsidies/tariffs on importers (recall that these are assumed to be symmetric in both countries). The welfare gains from trade increase to more than 30% as the import share increases from autarky to 40%. By contrast, absent producer heterogeneity, the gains from trade are much smaller. Moving from autarky to free trade leads to welfare gains of only about 5%. Absent heterogeneity, markups are little affected by trade policies since there is little concentration even in autarky. But in our model markups decline by about 25% as we move from autarky to a 40% import share.

Our model predicts a non-monotonic relationship between trade and TFP. Aggregate TFP reaches its peak when the import share is 22%, i.e., when the trade subsidy is 0, and declines as we subsidize or tax imports. Intuitively, subsidies on trade distort allocations since they increase the share of output spent on iceberg trade costs $\tau$, thereby reducing TFP.

Our model also predicts a nonlinear relationship between trade and TFP. Most of the gains from trade accrue for minor increases in the import share away from 0. For example, increasing the import share from zero to 10% gives welfare gains of about 25%. Further increasing the import share, from 10% to 40%, raises welfare by only an additional 5 or 6%. This nonlinearity is driven by the very convex relationship between markups and market shares in the model. Even a small increase in the amount of competition faced by domestic firms is enough to reduce their markups significantly.

Importantly, the greater welfare gains from trade in our model, relative to a standard model are not driven by generating a substantially lower Armington elasticity. The lower-right panel of Figure 2 shows that the Armington elasticity in our model varies from 8.5 to 7.4 as we vary the import share from zero to 40% and is thus not too different from that in the economy without heterogeneity.
D. Comparison with Arkolakis, Costinot and Rodríguez-Clare

Arkolakis, Costinot and Rodríguez-Clare (2011) have shown that, in a large class of models of international trade, the welfare gains of changes in trade costs that lead to a change in the share of spending on domestic goods equal to $\Delta \log \lambda$ are given by:

$$\frac{1}{1-\sigma} \Delta \log \lambda$$

Although the class of models Arkolakis et al (2011) study does not nest our economy with the pro-competitive effect on markups, we find it instructive to evaluate how TFP and welfare change in our model economy in response to changes in trade costs. This calculation allows us to isolate the role of TFP gains due to standard love-of-variety effects (as captured by the above formula) from those induced by a trade-induced decline in misallocation.

Figure 3 shows how welfare and TFP change in our Benchmark model as well as in a standard trade model with no within-industry heterogeneity (i.e., $\theta = \gamma$) as we vary the trade cost from $\tau = \infty$ (no trade) to $\tau = 0$ (50% import share). Since Arkolakis et al (2011) abstract from capital accumulation and assume inelastic labor supply, their welfare calculations apply to the level of TFP. We therefore also report how TFP varies with changes in trade costs in the class of standard trade models they consider.

Figure 3 shows that once again our model predicts substantial gains from trade. Raising the import share from 0 to 10% raises welfare by 25% in our model, compared to about 2.2% in the standard trade model. Such a change in import shares raises TFP by about 12% in our model and by about 1.2% in the standard model. A TFP response of 1.2% in the standard trade model is exactly what the Arkolakis et al (2011) formula predicts for our parameter values.

6. Evidence in Support of the Pro-Competitive Mechanism

Our model predicts that industries with higher import shares are characterized by more competition, and therefore both lower labor (revenue) productivity and lower dispersion in labor productivity. We next describe the evidence from the Taiwanese manufacturing data on these predictions of the model.
A. Mean/Median Labor Productivity

Panel A of Table 4 divides our industries into two subgroups: those with low import shares (less than 25%), and those with high import shares (greater than 25%) that are exposed to relatively more foreign competition. We find that the mean labor productivity of producers in industries that are more open is about 2.4% lower than the labor productivity of producers in industries that are less open. The difference in medians is slightly greater at 2.8%. The gap between revenue-weighted means and medians is even greater, the difference in means is 10.4% and in medians is 6%. This is consistent with the model’s prediction that trade mostly affects the markups of the larger producers.

Panel B of Table 4 illustrates the same point using regressions of log labor productivity on import shares. We again find a strong negative relationship between the two, with elasticities that range from $-0.067$ (unweighted regressions) to $-0.198$ (weighted regressions).

B. Dispersion in Labor Productivity

Panel C of Table 4 shows that the dispersion in labor productivity across producers in an industry is also negatively related to the import share. This most strongly manifests itself in the gap between, say, the 95th and 50th percentiles of the distribution, but the standard deviation is negatively correlated with import shares as well. That the tails of the distribution of labor productivity are most closely related to trade is again consistent with the nonlinear relationship between markups and market shares in the model. For example, when we weight industries by their revenue share, we find that increasing import shares from 0 to 50% leads to a 12% reduction (i.e., $-0.239 \times 0.5 = -0.12$) in the gap between the labor productivity of the 95th and 50th percentiles of the distribution of labor productivity within an industry.

7. Conclusions

[TO BE COMPLETED]
References


Arkolakis, Costas, Arnaud Costinot, and Andrés Rodríguez-Clare. 2010. Gains from trade under monopolistic competition: A simple example with translog expenditure functions and Pareto distributions of firm-level productivity. Manuscript, Yale University.


Table 0: Data Description

A. An example of product classification

<table>
<thead>
<tr>
<th>3-digit</th>
<th>314: Computers and Storage Equipment</th>
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</thead>
<tbody>
<tr>
<td>5-digit</td>
<td>31410 - Computers</td>
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<td>7-digit</td>
<td>3141000 - mini-computer</td>
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<td></td>
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<td>3141021 - desktop computer</td>
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<td>3141024 - palmtop computer</td>
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<td></td>
<td>3141025 - pen-based computer</td>
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<tr>
<td></td>
<td>3141026 - hand held computer</td>
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<td></td>
<td>3141027 - electronic dictionary</td>
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B. Distribution of products, sectors, and industries

<table>
<thead>
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<th>2-digit (sector)</th>
<th>4-digit (industry)</th>
<th>7-digit (products)</th>
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</thead>
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### Table 1: Acronyms

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<td>Industries</td>
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<td>RM</td>
<td>Retrospective Model</td>
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### Table 2: Additional Statistics

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<th>Contraction Statistics incl. Importers</th>
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### Table 3: Data Model

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Table 2: Additional model predictions

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<th>Model</th>
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</tr>
<tr>
<td>s.d. markup</td>
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<tr>
<td>median markup</td>
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<td>95th p.c. markup</td>
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<td>99th p.c. markup</td>
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<td>median labor share</td>
<td>0.62</td>
</tr>
<tr>
<td>aggregate labor share</td>
<td>0.24</td>
</tr>
<tr>
<td>s.d. markup</td>
<td>0.46</td>
</tr>
<tr>
<td>mean markup</td>
<td>1.11</td>
</tr>
<tr>
<td>1/17</td>
<td></td>
</tr>
</tbody>
</table>
Table 3: Losses due to markups

<table>
<thead>
<tr>
<th>Benchmark Model</th>
<th>Benchmark</th>
<th>First-Best</th>
<th>No markup dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.59</td>
<td>1.01</td>
<td>0.35</td>
</tr>
<tr>
<td>L</td>
<td>-0.50</td>
<td>0.89</td>
<td>0.35</td>
</tr>
<tr>
<td>TFP</td>
<td>-0.07</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>Welfare gains, %</td>
<td>-19.0</td>
<td>9.5</td>
<td>48.9</td>
</tr>
</tbody>
</table>

Notes: First-Best is the economy with no markups. The economy with no markup dispersion keeps the aggregate markup constant. Columns I and II report log-deviations from Benchmark values for Y, C, L, and TFP. We report welfare gains using consumption-equivalent changes. We report (italicized) identical calculations for an economy in autarky.
<table>
<thead>
<tr>
<th>Import Share</th>
<th>A. Labor Productivity vs. Import Share</th>
<th>Log-difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.25</td>
<td>1.57</td>
<td>1.44</td>
</tr>
<tr>
<td>&gt; 0.25</td>
<td>1.79</td>
<td>1.81</td>
</tr>
</tbody>
</table>

Weighted mean:
- Import Share < 0.25: 1.73
- Import Share > 0.25: 1.84

Weighted median:
- Import Share < 0.25: 1.69
- Import Share > 0.25: 1.57
Table 4: Labor Productivity vs. Import Shares in Taiwan Manufacturing

<table>
<thead>
<tr>
<th></th>
<th>Unweighted</th>
<th>Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B. Log Labor Productivity vs. Import Share Regressions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant-level (single-product)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product-level (single-product family)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant-level labor productivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C. Industry-level Dispersion Log Labor Productivity vs. Import Share Regressions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry productivity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Statistics are computed for non-exporting plants.
Figure 1: Distribution of sectoral shares and markup
Figure 2: Gains from Trade Subsidies

Our model

Standard model
Figure 3: Gains from Reduction in Trade Costs

Our model
Standard model

Welfare gains, %

import share

TFP