Quantifying the Impacts of Local Content Requirements: An Analysis on Indonesia *

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Abstract

We quantify the impacts of a local content requirement (LCR) policy that promotes the use of domestic content in the upstream oil and gas sector on the Indonesian economy. We develop a model of foreign sourcing with an LCR compliance decision. An LCR-bound firm chooses to comply with the LCR or not by weighing the cost penalty of compliance and the non-compliance cost. We find that the LCR leads to reallocation of sales to the upstream oil and gas sector between compliers and non-compliers, but generates small effects on aggregate sales, value-added, and employment. The LCR not only increases local content of compliers, but also raises domestic input costs and reduces the local content of non-binding firms and non-compliers, causing the aggregate local content to decline. Therefore, an attempt to increase aggregate local content using LCR may generate an unintended effect.

Keywords: Local Content Requirement, Foreign Sourcing, Firm Heterogeneity

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1 Introduction

The fragmentation of the value chain across the globe increases the foreign content of goods produced in all countries. Policymakers have thus emphasized the importance of tracing how much local factors of production or locally-produced inputs are used in the making of final goods, and how effective the incentives provided to producers to encourage purchases from local suppliers are in promoting local production and employment. In various countries, we see the increasing use of local content requirements (LCRs) that require a minimum level of domestically-produced inputs in the production or value added. Bilateral or regional free trade agreements or economic partnerships adopt LCRs (or regional content requirements) as well as ROOs (rules of origins) to prevent trans shipment from non-member countries. Some host countries of foreign direct investment (FDI) also require a certain percentage of local factors of production and inputs to be used in producing final goods, in order to boost the local economy through backward linkages. Thus, evaluating a commercial policy usually requires quantifying the impacts of LCR.

This chapter attempts to quantify the impacts of LCR on Indonesian manufacturing firms and sectors. We focus on a single regulation issued in May 2013 by the Ministry of Energy and Mineral Resources, whose primary goal is to promote the use of domestic content in upstream oil and gas business activities, protecting domestic sectors and employment from foreign competition. In 2012, the upstream oil and gas (OG henceforth) sector accounted for about 12% of Indonesia's value-added, so it is an important sector of Indonesia's national economy. The LCR imposed by this regulation potentially affects all firms that supply inputs to the upstream OG sector in Indonesia, so it is of great policy interest to study the impacts of this regulation on the Indonesian economy.

We introduce LCR compliance decisions faced by manufacturing firms into the model developed by Blaum et al. (2018) and study the effects of the LCR on firms and sectors. Firms use both domestic content and foreign content in their production, and these inputs are assumed to be imperfect substitutes. An LCR specifies that at least a minimum percentage share (in value) of local content should be used in local production. On the one hand, a failure to comply with the LCR results in an *ad valorem* non-compliance fee

when a firm sells to the upstream OG sector. On the other hand, if the LCR is binding for the firm, compliance distorts the firm's sourcing decision and induces a cost penalty compared with the unit cost of unconstrained sourcing. An LCR-bound firm thus faces a trade-off between the non-compliance fee and the cost penalty due to compliance. The model allows firms to differ in their efficiency of using foreign content. Intuitively, if a firm is more dependent on foreign content, the cost penalty of compliance is higher, and the firm is less likely to comply. The model thus helps us to determine the cost penalty for each firm, given other firm characteristics.

The changes in costs and prices of compliers and non-compliers transmit to the sector-level price indexes, affecting the production costs of firms that find their LCR non-binding through the cross-sector input-output linkages. Following Dekle et al. (2007), we solve for the changes in firm-level unit costs, sales, employment, and sector-level price indexes in the equilibrium, so we can evaluate the impacts of the LCR imposition on the firm-level and sector-level outcomes.

We calibrate the initial equilibrium to Indonesian economy prior to the LCR introduced in 2012. We then study the impacts of the LCR. Our finding are as follows. 1) Only 7% of manufacturing firms with low local content in the economy are constrained by the LCR. Among these LCR-bound firms, those that import relatively more are less likely to comply with the LCR. The compliers account for about 7% among the LCR-bound firms. 2) LCR does cause substantial responses and reallocation of firm-level sales to the OG sector. On average, the sales of compliers to the OG sector increase by 13%, and the sales of non-compliers to the OG sector decrease by 34% due to the non-compliance fees. 3) The changes in sales to non-OG sectors of different types of firms are between -0.5% to 0.1% and result in very small changes in firm-level sales and value-added. Due to compliers' decisions to raise their local content, their employments, which constitute part of their local content, increase by 8% on average. At the national level, the effects on aggregate sales, value-added and employment are also small. 4) Although the LCR imposition causes the average local content of compliers to increase from 37% to 40%, it also raises costs of domestic inputs for all firms and leads to small declines in the local content of non-binding firms and non-compliers that are much more populous in the economy. The aggregate local content thus declines slightly from 83.96% to 83.95%, indicating a qualita-

tively unintended consequence of the LCR policy when domestic input costs are affected by the policy in general equilibrium, although the effect is quantitatively small in this case. 5) The price index increases for goods sold to the OG sector are much larger than the price index increases for goods sold to the non-OG sectors. As a result, domestic input costs and consumer prices increase by small amounts.

This chapter is closely related to the literature analyzing the implications of local and regional content requirements. Earlier theoretical investigations (e.g., Grossman, 1981; Krishna and Itoh, 1988; Ju and Krishna, 2005) suggest that the effects of LCR on domestic prices, resource allocations, and welfare hinge on specific assumptions, such as the form of the LCR, the market structure, and the degree of substitutions between inputs. Subsequent theoretical analyses also discuss the optimal LCR policy when such requirements apply to foreign investment firms in the domestic market (e.g., Lahiri and Ono, 1998; Qiu and Tao, 2001). Due to data limitations, empirical studies examining the effects of LCR, mostly those of ROOs, have only emerged in recent years. Conconi et al. (2018) shows that the ROOs of the North American Free Trade Agreement (NAFTA) cause the imports of intermediate inputs from non-NAFTA partner countries to Mexico to decline, a "trade diversion effect". Focusing on the NAFTA rules of origin on automobile parts, Yang (2021) shows that the trade diversion due to ROOs is non-linear in the restrictiveness of the rules, measured by the regional value content requirement. In the context of NAFTA and USMCA, Head et al. (2022) points out that as regional content requirement becomes stricter, intra-regional sourcing may eventually decline because more producers choose not to comply with the regional content requirement, generating a "Laffer curve" of regional content share. To complement the existing studies, we quantify the effects of Indonesia's LCR by accommodating firm-specific compliance decisions in an equilibrium model. Our quantitative results show that the effects of imposing the LCR are highly asymmetric across firms.

This chapter also connects to the literature on imported intermediate inputs, global sourcing, and firm-level production cost and efficiency. A number of empirical studies show that declining costs of imported intermediate goods due to trade liberalization lead to positive firm-level outcomes, such as increased productivity, new varieties, and export quality (see for example, Amiti and Konings, 2007; Goldberg et al., 2010; Fan et al., 2015;

De Loecker et al., 2016; Brandt et al., 2017). Our theoretical model follows Blaum et al. (2018) in treating domestic input and imported input made by the same sector as substitutes in a constant-elasticity-of-substitution (CES) production function. Using a similar way of modelling the role of imported intermediate inputs, Gopinath and Neiman (2014) and Antras et al. (2017) study the extensive margin of foreign sourcing in the product dimension and the country dimension. These studies mostly focus on the effects of foreign shocks common to domestic importing firms, such as tariff reductions, exchange rate movements, and foreign productivity shocks. We apply a similar framework to study a policy that is somewhat discriminatory across importing firms: For a given level of LCR, import-intensive firms suffer higher compliance costs and therefore are less likely to comply.

The rest of the chapter is structured as follows. Section 2 describes the regulation and LCR for Indonesia's upstream OG sector and reports data patterns. Section 3 introduces the LCR compliance decisions into a model of local and foreign sourcing. Section 4 describes how we calibrate the model. Section 5 reports and discusses the quantitative results. Section 6 concludes.

2 Indonesia's LCR for the Upstream OG Sector

Since 2010, Indonesia has used LCRs to regulate the local content of goods produced in Indonesia. The primary motivation for using LCR is to promote the purchase of domestic inputs and reduce the dependence on imported imported inputs, protecting domestic sectors and employment. In this chapter, we draw attention to one particular LCR introduced by the "Ministry of Energy and Mineral Resources (MEMR) Regulation No.15 of 2013 concerning the Use of Domestic Products in Upstream Oil and Gas Business Activities" (referred to as the "MEMR regulation" henceforth). The MEMR regulation was designed to promote the use of domestic goods and services in Indonesia's upstream OG business activities. Upstream OG business activities are business activities focused or based on exploration and exploitation of oil and natural gas, and account for a significant share of Indonesia's economy. In 2012, the upstream OG sector generates 8.3% of the gross output and 11.9% of the value-added of Indonesia, whereas it only accounts for

4.5% of the intermediate input spending and 1% of the employment in the economy.[1]

As outlined in the MEMR regulation, the government of Indonesia requires every contractor, local producer, and supplier of goods and services involved in upstream OG operations to use domestic goods and services whenever possible. In addition, these parties are encouraged to maximize their use of domestic goods and services. In particular, it specifies the minimum percentages of local content that must be achieved in government procurement bidding by upstream OG contractors when they choose their suppliers of goods and services, and offers price preferences as rewards to firms who comply with the local content requirements or charges a non-compliance fee to firms who do not comply with the requirements.[2] Since the Indonesian government acts as the "owner" of the contract areas for exploration and exploitation of oil and natural gas resources, it appears reasonable to assume that firms not complying with the LCR suffer a price disadvantage when providing goods or service to the upstream OG business in Indonesia.

We focus on the impacts of the regulation on manufacturing firms. A manufacturing firm that may supply inputs to contractors in the upstream OG business activities is faced with a decision of whether to comply with the local content requirement. For example, drilling pipe is a necessary component to any drilling rig designed to extract oil from the ground, so it is an important input for the contractors in the upstream OG sector. A manufacturing firm producing drilling pipes may choose not to comply with the LCR if it heavily relies on imported inputs (e.g., imported steel) to produce drilling pipes. However, if the upstream OG sector is a major revenue source for this manufacturing firm, the firm may find complying with the LCR optimal as it cannot afford losing its competitiveness in such an important market.

A manufacturing firm may also lie about its compliance status to both avoid paying the non-compliance fee and escape the limits on the use of imported inputs. Such behavior, if discovered, results in an administrative sanction imposed by the Indonesian government. One of the most severe sanctions is a revocation of *Letter of Capability for Oil and Gas Supporting Business* and a ban from supplying goods to the upstream oil and nat-

[1] From 2005 to 2014, the sector's share in Indonesia's economy has been quite stable. For example, the share of value-added generated by the upstream OG sector is 10% to 12% during this period.

[2] According to the MEMR regulation, a price preference is "*an adjustment value or normalization of the price against bid price in the procurement of goods and/or service.*"

ural gas sector. Therefore, if the probability of getting caught is high, the manufacturing firm will not choose to lie about its compliance status.

What are the levels of LCR imposed by the MEMR regulation? Appendix I of the regulation provides the target levels of LCR applied to suppliers of different goods. Table 1 shows the target LCR levels. Suppliers of different goods are subject to different levels of LCR, and these goods are important inputs in the exploration and exploitation of OG resources. For example, as shown in the first row of Table 1, a producer of *high-grade drilling pipes* should demonstrate that at least 25% of its costs are of local content in order to receive a price preference or to avoid being charged a non-compliance fee of 15% as a supplier for contractors in the upstream OG business activities during the period of 2013–2016. The target LCR levels increase over time, revealing the motivation of the Indonesian government to promote increasing usage of domestic goods and labor.

Table 1: LCR Levels of Different Goods

Goods	Target LCR level (%)		
	Short-term (2013–2016)	Medium-term (2017–2020)	Long-term (2021–2025)
1. Drilling pipe			
a. High-grade	25	40	55
b. Low-grade	15	25	40
2. Distribution pipe (line pipe)			
a. Spiral/SAW	50	65	80
b. ERW	50	65	80
c. Seamless pipe	10	30	50
3. Drilling mud, cement and chemicals	40	55	70
4. Electrical submersible pump	15	25	35
5. Pumping unit	40	55	70
6. Machinery & equipment	20	30	40
7. Wellhead and X-mas tree			
a. Onshore	40	55	70
b. Offshore	15	30	40
8. Fuel oil (BBM)	60	75	95
9. Lubricant	50	60	70
10. Other goods	15	25	40

2.1 Data and Basic Patterns

Since the MEMR regulation aims at promoting the use of local content, its effects hinge on how many manufacturing firms import inputs from abroad, and how many of them may be constrained by the LCR. For this analysis, we use a micro-level data set of Indonesian manufacturing firms provided by Statistics Indonesia (BPS). The data set reports responses from an annual survey of large and medium-sized manufacturing firms, covering information on gross production output, number of workers, wages, capital stock, expenditure on domestic materials, and expenditure on foreign materials. The data set also provides information on production at the firm-product level.[3] We define 18 sectors in the economy, including agriculture, mining, service, and 15 manufacturing sectors.

We focus on the "long-term" LCR targets. To define the exact level of LCR faced by each manufacturing firm, we identify firms that produce goods listed in Table 1 (including "10. Other goods", for instance, motor vehicle) and match them to the corresponding LCR levels.[4] The majority of firms are classified into the "Other goods" category and are hence subject to a long-term LCR level of 40%.

A firm i's local content λ_i is computed as

$$\lambda_i = \frac{c_{D,i}M_{D,i} + wL_i}{c_{F,i}M_{F,i} + c_{D,i}M_{D,i} + wL_i}, \tag{1}$$

where $c_{D,i}M_{D,i}$, $c_{F,i}M_{F,i}$ and wL_i are firm i's expenditure on domestic materials, imported materials, and wage bill, respectively.

We first report some descriptive statistics to examine the stringency and the coverage of the LCR imposed by the MEMR regulation. Since the MEMR regulation went into effect in 2013, we focus on the firm-level information for 2012. The last row of Table 2 shows that among the 21,078 manufacturing firms, the average local content is 91.3%, so an average manufacturing firm spends about 91% of its production costs on Indonesian-produced goods and Indonesian workers. Among these firms, only 21.5% are importers of inputs. We find that in 2012, only 6.7% of firms' local content is lower than their corresponding LCR.

[3] A "product" is defined as a unique Kode Klasifikasi Industri (KKI) 9-digit code.

[4] If multiple products produced by a firm are subject to different levels of LCR, we use their maximum for simplicity.

Table 2: Firm-level Local Content by Sector, 2012

Manufacturing Sector	(1) No. of firms	(2) Avg. local content (%)	(3) Share of importers (%)	(4) Local content $<$ LCR (%)
Food & Beverages	6,772	97.3	13.5	1.7
Textile & Apparel	3,910	90.3	21.2	6.7
Wood Products	1,015	97.3	16.1	1.6
Paper Products	447	89.8	22.1	7.8
Printing & Reproduction	461	96.6	18.9	1.3
Coke & Refined Petroleum	67	84.4	29.9	11.9
Chemicals & Medicine	1,053	75.4	46.0	20.7
Rubber & Plastic	1,553	88.7	26.4	8.0
Non-metallic Minerals	1,610	95.2	14.3	3.5
Basic Metals	241	75.3	47.3	23.7
Fabricated Metals	750	84.5	31.2	13.2
Electronic & Equipment	785	70.1	48.3	27.6
Motor Vehicles	267	77.5	40.4	18.7
Other Transportation Equipment	217	74.3	43.3	23.5
Other Manufacturing	1,930	93.3	19.1	4.9
All Firms	21,078	91.3	21.5	6.7

Different sectors exhibit diverse behavior regarding their usages of local content. As shown in Table 2, firms operating in the sectors of "Coke & Refined Petroleum", "Chemicals & Medicine", "Basic Metals", "Electronic & Equipment", and "Other Transportation Equipment" import more and are more likely to be contrained by the LCR. These sectors are also more likely to supply inputs to the upstream OG sector. Therefore, we expect the LCR imposition to yield larger effects on firms operating in these sectors. On the other hand, sectors such as "Food & Beverages" and "Wood Products" have very high local content and are less likely to be suppliers of the upstream OG sector.

To further examine heterogeneity across sectors, we plot Table 2 Column 4 against Table 2 Column 2 in Figure 1. The downward-sloping relationship suggests that in sectors with lower average local content, more firms may be constrained by the LCR because the shares of firms relying on foreign inputs are larger.

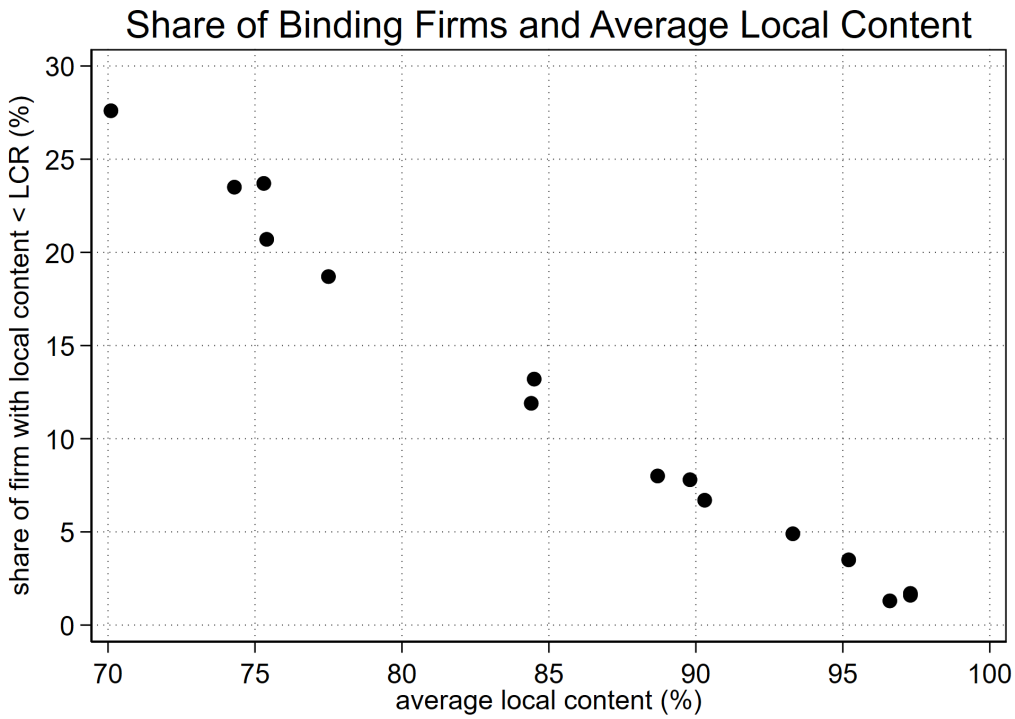

Figure 1: Share of Constrained Firms and Average Local Content

Empirical studies have found that firms that engage in international trade are usually larger firms. This is also true for Indonesian importers. Figure 2 plots the distributions of log market share (relative to the sectoral mean) for non-importers and importers. Clearly, importers have higher market shares than non-importers, consistent with the findings of the recent literature (e.g., Antras et al., 2017; Blaum et al., 2018). We also distinguish the distributions of importers with different levels of local content. The market shares of importers with local content lower than their LCR are slightly larger than those of other importers. It appears that firm size is negatively correlated with the likelihood of being constrained by the LCR.

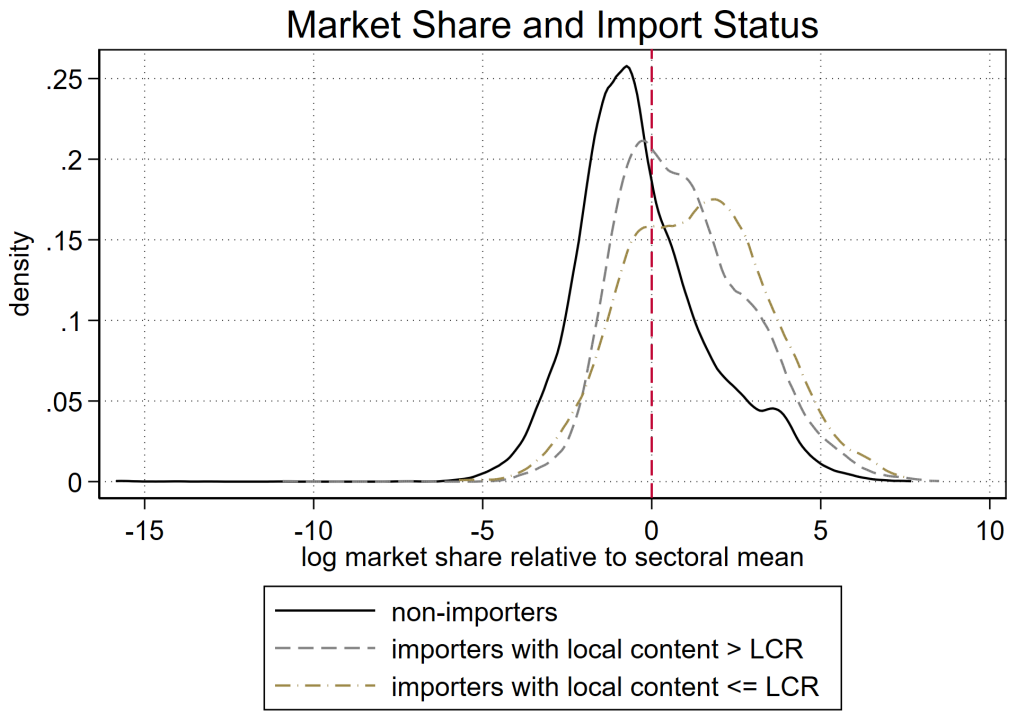

Figure 2: Market Share and Import Status

We conclude this section by comparing the distributions of local content across firms before and after the LCR imposition. Figure 3 plots the distributions of local content in 2012 and 2014 for importing manufacturing firms. Comparing the two distributions, we notice that the probability density below 35% of 2014 is lower than that of 2012, while the probability density above 35% of 2014 is higher than that of 2012. This pattern seems to indicate that certain importers begin to comply with the LCR by increasing their local content, while there exists a large group of firms that choose not to comply with the regulation.

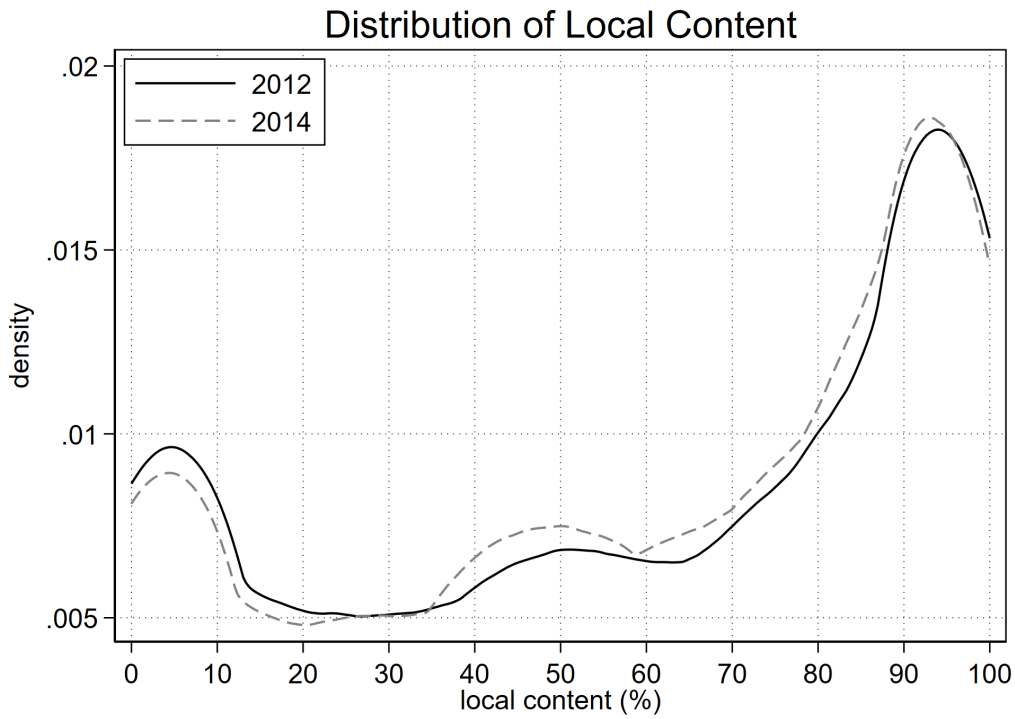

Figure 3: Distributions of Local content for Importers

In sum, this section suggests that the impact of the LCR imposition may vary by sector. Certain sectors are more likely to be affected, because they host a large number of importing firms that rely heavily on imported inputs. It also shows that within a sector, larger manufacturing firms are more likely to be constrained by the LCR than smaller firms.

3 Model

In this section, we introduce the LCR compliance decision into a model with firm heterogeneity to describe the implications of the policy for Indonesian firms and for the economy. Following Antras et al. (2017) and Blaum et al. (2018), local content and foreign content are imperfect substitutes in a firm's production function. Local content consists of domestic inputs and labor, while foreign content only consists of imported inputs. The LCR specifies a threshold for the share of foreign content and introduces a cost penalty by distorting the firm's sourcing decision in the case of "binding compliance", under which

the firm would have chosen a higher share of foreign content absent the LCR. A firm that complies with the LCR avoids paying an *ad valorem* non-compliance fee of 15% when supplying their goods to the upstream OG sector.

The cost changes of the LCR-bound firms transmit to the sector-level domestic price indexes and affect the input costs of other firms through the input-output linkages. We construct an equilibrium model to capture these features and use this model to evaluate the effects of the LCR imposition on firms and sectors.

3.1 Firm-level Sourcing Decision without LCR

We begin by describing firm-level sourcing decisions without LCR. We assume that a firm i combines local content $M_{D,i}$ and foreign content $M_{F,i}$ to produce output Y_i using a constant-elasticity-of-substitution (CES) aggregator,

$$Y_i = \varphi_i \cdot [(a_{D,i} \cdot M_{D,i})^{\frac{\theta-1}{\theta}} + (a_{F,i} \cdot M_{F,i})^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}}, \tag{2}$$

where $\theta > 1$ is the elasticity of substitution between local content and foreign content for firms. The parameters $a_{D,i}$ and $a_{F,i}$ represent the efficiencies of firm i in using local content and foreign content, generating firm-specific domestic input share. The parameter φ_i is a Hicks-neutral productivity shifter that differs by firm. Denote the firm-specific costs of local content and foreign content as $c_{D,i}$ and $c_{F,i}$, the cost share of local content used by firm i is

$$\lambda_i = \frac{(c_{D,i}/a_{D,i})^{1-\theta}}{(c_{D,i}/a_{D,i})^{1-\theta} + (c_{F,i}/a_{F,i})^{1-\theta}} = \frac{1}{1+\delta_i^{1-\theta}}, \quad \delta_i = \frac{c_{F,i}/a_{F,i}}{c_{D,i}/a_{D,i}}. \tag{3}$$

The parameter δ_i measures the firm-specific relative (efficiency-adjusted) cost of foreign content. An increase in international trade cost raises δ_i for all firms. The differences in δ_i across firms capture the fact that firms differ in their ability to source and use foreign content. Hence, without LCR, the unit cost of Y_i is

$$c_i = \frac{c_{D,i}}{\varphi_i a_{D,i}}(1+\delta_i^{1-\theta})^{\frac{1}{1-\theta}} = \frac{c_{D,i}}{\varphi_i a_{D,i}} \cdot \lambda_i^{\frac{1}{\theta-1}}. \tag{4}$$

The model is similar to that of Blaum et al. (2018). The main implication is that, conditional on the efficiency-adjusted cost of local content $c_{D,i}$ and productivity φ_i, the ob-

served firm-level domestic input share λ_i is a sufficient statistic for the firm-level unit cost c_i. So given the cost of local content $c_{D,i}$, productivity φ_i and the firm-level domestic input share λ_i, no additional information is needed in order to infer c_i.[5]

Furthermore, the local content $M_{D,i}$ is produced by local labor and composite domestic input. The production technology of $M_{D,i}$ is a CES aggregator given by

$$M_{D,i} = [(b_{L,i} \cdot L_i)^{\frac{\theta-1}{\theta}} + (Q_{D,i})^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}}, \tag{5}$$

where L_i is the amount of labor used and $Q_{D,i}$ is the amount of composite domestic input used by firm i. We describe the production of composite domestic input in subsection 3.3. The parameter $b_{L,i}$ represents a firm-specific labor-augmented efficiency. For simplicity, we assume that the elasticity of substitution between labor and composite domestic input is also θ. Such a formulation indicates that a manufacturing firm is considering a "make or buy" decision when sourcing its local content. Meanwhile, we assume that the foreign content $M_{F,i}$ is only produced by the composite foreign input.

Using superscript k to denote the sector in which firm i operates, we have the following expressions for the costs of domestic and foreign content of firm i

$$\begin{aligned} c^k_{D,i} &= [(P^k_D)^{1-\theta} + (w^k / b_{L,i})^{1-\theta}]^{1/(1-\theta)} = P^k_D (\gamma_i)^{\frac{1}{\theta-1}}, \\ c^k_{F,i} &= P^k_F. \end{aligned} \tag{6}$$

In the expressions above, P^k_D and P^k_F are the price indexes of composite domestic input and composite foreign input for firms in sector k. The variables w^s and γ_i denote the sector-specific wage and the cost share of composite domestic input in firm i's total cost of local content.

3.2 The Impacts of LCR on Unit Cost

Next, we discuss how the LCR affects firm-level sourcing decisions and their unit costs. Suppose that a firm is subject to a LCR level of $\underline{\lambda}_i$, that is, it requires that at least $\underline{\lambda}_i$ share of firm i's content should be spent on local content to avoid being charged a non-compliance

[5] For simplicity, we do not endogenize $P_F / a_{F,i}$. Gopinath and Neiman (2014) and Antras et al. (2017) specify two different channels through which $P_F / a_{F,i}$ may respond to changes in the import environment.

fee. If the LCR is binding for firm i (so $\lambda_i \leq \underline{\lambda}_i$) and the firm decides to comply with it, its sourcing decision is determined by

$$\frac{M_{D,i}}{M_{F,i}} = \frac{\underline{\lambda}_i}{1-\underline{\lambda}_i}\frac{c_{F,i}}{c_{D,i}}. \tag{7}$$

Such a sourcing decision implies the following unit cost of Y_i,[6]

$$\kappa_i \cdot c_i, \tag{8}$$

where

$$\kappa_i = \left[\underline{\lambda}_i\left(\frac{\lambda_i}{\underline{\lambda}_i}\right)^{\frac{1}{\theta}} + (1-\underline{\lambda}_i)\left(\frac{1-\lambda_i}{1-\underline{\lambda}_i}\right)^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\theta}}, \quad \lambda_i \leq \underline{\lambda}_i. \tag{9}$$

When firm i complies with the binding LCR, its foreign sourcing decision is distorted. Hence, it is subject to a cost penalty κ_i if its "unconstrained" local content λ_i is lower than the one required by the LCR. It can be shown that $\kappa_i \geq 1$ and that $\kappa_i = 1$ if and only if $\lambda_i = \underline{\lambda}_i$, namely, when the unconstrained local content coincides with the required LCR level.[7]

If $\lambda_i > \underline{\lambda}_i$, the LCR is non-binding for firm i and would not affect its sourcing decision, so its unit cost continues to be equal to c_i. On the other hand, if $\lambda_i \leq \underline{\lambda}_i$ and the firm chooses not to comply with the LCR, its unit cost remains equal to c_i. However, it is subject to an *ad valorem* non-compliance fee when selling to the upstream OG sector, specified in the later discussion.

Therefore, when an LCR is present, firm i's unit cost C_i is

$$C_i = \begin{cases} c_i, & i \in \Omega_{\text{NB}} \cup \Omega_{\text{NC}}, \\ \kappa_i \cdot c_i, & i \in \Omega_{\text{C}}, \end{cases} \tag{10}$$

where Ω_{NB} is the set of firms that find the LCR to be non-binding, Ω_{NC} is the set of

[6] To calculate $\underline{c}_i$, one simply needs to calculate $c_{D,i} \cdot M_{D,i} + c_{F,i} \cdot M_{F,i}$ subject to the following two constraints:

$$(c_{D,i} \cdot M_{D,i})/(c_{F,i} \cdot M_{F,i}) = \underline{\lambda}/(1-\underline{\lambda}) \text{ and } [(a_{D,i} \cdot M_{D,i})^{\frac{\theta-1}{\theta}} + (a_{F,i} \cdot M_{F,i})^{\frac{\theta-1}{\theta}}]^{\frac{\theta}{\theta-1}} = 1.$$

[7] To see this, notice that $\partial(\kappa_i)^{\frac{1-\theta}{\theta}}/\partial\lambda_i = 0$ and $\partial^2(\kappa_i)^{\frac{1-\theta}{\theta}}/\partial(\lambda_i)^2 = \frac{1-\theta}{\theta}[(\underline{\lambda})^{-1} + (1-\underline{\lambda})^{-1}] < 0$ when $\lambda_i = \underline{\lambda}$. Recall that $\theta > 1$.

firms that chooses not to comply with the LCR, and Ω_C is the set of firms that chooses to comply with a binding LCR.

3.3 Demand and Firm Size

We next discuss the demand faced by firm i in the economy. We use superscripts to denote sectors. To model the demand faced by firm i in sector s from another sector k, we assume that in each sector k there exist perfectly competitive producers of a composite domestic input. These composite domestic input producers first purchase outputs supplied by firms in sector s, and combine these outputs to produce $Q_D^{k,s}$, a composite domestic input produced using sector-s outputs. The production technology of $Q_D^{k,s}$ is a CES aggregator given by

$$Q_D^{k,s} = [\sum_{i \in \Omega^s} (z^{k,s} \cdot q_i^{k,s})^{\frac{\sigma^s - 1}{\sigma^s}}]^{\frac{\sigma^s}{\sigma^s - 1}}, \quad \sigma^s > 1. \tag{11}$$

The variable $q_i^{k,s}$ refers to the quantity of goods produced by firm i in sector s and purchased by sector k, while the variable $z^{k,s}$ refers to the attractiveness or quality of that variety perceived by sector k.[8] The set Ω^s is the set of active varieties/firms in sector s.[9]

The composite domestic input producers of sector k further combine $Q_D^{k,s}$ across s to generate a composite domestic input Q_D^k for firms in sector k using the following Cobb-Douglas production function,

$$Q_D^k = \Pi_s (Q_D^{k,s})^{\beta_D^{k,s}}, \tag{12}$$

where $\beta_D^{k,s}$ is the cost share of outputs produced by sector s in sector k's total domestic input expenditure. We assume $\sum_s \beta_D^{k,s} = 1$.

The demand for firm i's output by composite domestic input producers of sector k is

$$q_i^{k,s} = (p_i^s)^{-\sigma^s} (z^{k,s})^{\sigma^s - 1} (P_D^{k,s})^{\sigma^s - 1} X^{k,s}, \tag{13}$$

[8] In principle, we can allow $z^{k,s}$ to differ by i, namely, firms may differ in their attractiveness perceived by sector k. However, calibrating a model with this dimension of firm heterogeneity will require information on individual firms' sales to different sectors, which is not available in our data.

[9] For simplicity, we assume that all active firms in sector s sell to sector k, because we do not observe what sectors a particular firm sells to, which may require information on firm-to-firm transactions.

where $X^{k,s}$ is sector k's total input expenditure spent on goods produced by sector s. The price index of $Q_D^{k,s}$ is

$$P_D^{k,s} = [\int_{i\in\Omega^s} (p_i^s / z^{k,s})^{1-\sigma^s}]^{1/(1-\sigma^s)}. \tag{14}$$

The price index of the composite domestic input for firms in sector k, Q_D^k, is

$$P_D^k = \Pi_s \Big(\frac{P_D^{k,s}}{\beta_D^{k,s}}\Big)^{\beta_D^{k,s}}. \tag{15}$$

Similarly, in each sector k also exist perfectly competitive producers of composite foreign input. We denote the price index of composite foreign input for firms in sector k as P_F^k. We assume that P_F^k is not affected by the LCR.

Firm i is a monopolistic competitor. Therefore, firm i's price p_i^s, sales $Y_i^{k,s}$, and profit $\pi_i^{k,s}$ generated by selling to sector k are as follows,[10]

$$\begin{aligned} p_i^s &= \frac{\sigma^s}{\sigma^s - 1} C_i, \\ Y_i^{k,s} &= \Big(\frac{\sigma^s}{\sigma^s - 1}\Big)^{1-\sigma^s} \Big(\frac{C_i}{z^{k,s}}\Big)^{1-\sigma^s} (P_D^{k,s})^{\sigma^s - 1} X^{k,s}, \\ \pi_i^{k,s} &= \frac{Y_i^{k,s}}{\sigma^s}. \end{aligned} \tag{16}$$

Besides selling goods to different domestic sectors, a manufacturing firm also sells its goods to domestic final consumers. We assume that the final consumption demand is also CES,

$$q_i^{F,s} = (p_i^s)^{-\sigma^s} (z^{F,s})^{\sigma^s - 1} (P^{F,s})^{\sigma^s - 1} X^{F,s}, \tag{17}$$

where the superscript F stands for final demand. The price index is

$$P_D^{F,s} \equiv [\int_{i\in\Omega^s} (p_i^s / z^{F,s})^{1-\sigma^s}]^{1/(1-\sigma^s)} + [\int_{i\in\Omega^{s*}} (p_i^s / z^{F,s})^{1-\sigma^s}]^{1/(1-\sigma^s)}, \tag{18}$$

where Ω^{s*} is the set of foreign manufacturing firms in sector s who serve Indonesian

[10] Theoretically, it is plausible to allow a firm to set differential prices to different sectors. However, we do not observe this information in the data.

consumers.

3.4 Compliance Decision

A manufacturing firm that chooses not to comply with the LCR is subject to a non-compliance fee, which is an *ad valorem* fee charged by the government in the procurement process of the upstream OG sector. In particular, if a firm i does not comply with the LCR, its price is inflated by a factor of $\tau > 1$ when selling to the upstream OG sector.

$$p_i^{k,s} = \begin{cases} \frac{\sigma^s}{\sigma^s - 1} \tau C_i, & \text{if } s = \text{OG}, \\ \frac{\sigma^s}{\sigma^s - 1} C_i, & \text{if } s \neq \text{OG}. \end{cases} \tag{19}$$

The potential firm-level profit, in the event of non-compliance, would be

$$\pi_{\text{NC},i}^s = (c_i)^{1-\sigma^s} [\Gamma^{\text{OG},s} (z^{\text{OG},s})^{\sigma^s - 1} \tau^{1-\sigma^s} + \sum_{k \neq \text{OG}} \Gamma^{k,s} (z^{k,s})^{\sigma^s - 1}], \tag{20}$$

where the constant $\Gamma^{k,s} = \frac{(\sigma^s - 1)^{\sigma^s - 1}}{(\sigma^s)^{\sigma^s}} (P_D^{k,s})^{\sigma^s - 1} X^{k,s}$ collects several sector-specific constants and variables.

If firm i chooses to comply with the LCR, it avoids paying the non-compliance fee of selling to the upstream OG sector but incurs a cost penalty κ_i. In this event, its firm-level profit would be

$$\pi_{\text{C},i}^s = (\kappa_i c_i)^{1-\sigma^s} [\sum_k \Gamma^{k,s} (z^{k,s})^{\sigma^s - 1}]. \tag{21}$$

A firm complies with the LCR if and only if

$$\pi_{\text{C},i}^s > \pi_{\text{NC},i}^s \iff S^{\text{OG},s} > \frac{1 - \kappa_i^{1-\sigma^s - 1}}{1 - \tau^{1-\sigma^s}}, \tag{22}$$

where

$$S^{\text{OG},s} = \frac{\Gamma^{\text{OG},s} (z^{\text{OG},s})^{\sigma^s - 1}}{\sum_k \Gamma^{k,s} (z^{k,s})^{\sigma^s - 1}}$$

is the firm's share of sales generated by sales to the upstream OG sector and measures the importance of the upstream OG sector as a market for firm i that operate in sector s. Note that $S^{\text{OG},s}$ does not differ by i because we assume that $z^{k,s}$ does not vary by i.

Inspecting (22), we find that the likelihood of compliance is increasing in $S^{\text{OG},s}$ and τ: A larger size of the upstream OG sector as a market and a higher non-compliance fee both induce a stronger incentive to comply. Meanwhile, a higher compliance cost penalty κ_i due to strong dependence on foreign content reduces willingness to comply.[11] For any given values of $S^{\text{OG},s}$ and τ, there exists a cutoff $\tilde{\lambda}_i$ such that for firms with unconstrained local content λ_i lower than the cutoff value $\tilde{\lambda}_i$, non-compliance dominates compliance.[12]

For a firm with its unconstrained local content higher than the LCR level $\underline{\lambda}_i$, the LCR is not binding and hence does not distort its sourcing decisions. Its profit is simply

$$\pi^s_{\text{NB},i} = (c_i)^{1-\sigma^s}[\sum_k \Gamma^{k,s}(z^{k,s})^{\sigma^s-1}]. \tag{23}$$

Firm i's compliance decision and the associated profit is determined by

$$\pi^s_i = \begin{cases} \pi^s_{\text{C},i}, & \lambda_i < \underline{\lambda}_i \text{ and } S^{\text{OG},s} > \frac{1-\kappa_i^{1-\sigma^s}}{1-\tau^{1-\sigma^s}}, \\ \pi^s_{\text{NC},i}, & \lambda_i < \underline{\lambda}_i \text{ and } S^{\text{OG},s} \leq \frac{1-\kappa_i^{1-\sigma^s}}{1-\tau^{1-\sigma^s}}, \\ \pi^s_{\text{NB},i}, & \lambda_i \geq \underline{\lambda}_i. \end{cases} \tag{24}$$

3.5 Equilibrium

We are now ready to describe the equilibrium and compare the equilibria without and with the LCR. We denote a variable in the initial equilibrium without LCR as x, and its counterpart in the equilibrium with LCR as x'. Following Dekle et al. (2007), we denote the relative change of a variable as $\hat{x} = x'/x$. We assume that firms can hire labor without any frictions at a given sector-specific wage rate w^s as in Blaum et al. (2018).

In the equilibrium, the price index of $Q^{k,s}_D$, the composite domestic input produced by

[11] Another potential option for a manufacturing firm is to misreport its compliance status in order to avoid the non-compliance fee without distorting its sourcing decision. Such a decision is only relevant for an LCR-bound firm. We assume that the probability of uncovering the misreporting is μ. In the event of getting caught, the firm faces an administrative sanction, resulting in a zero or even negative profit. Therefore, as long as the enforcement of the regulation is effective enough (meaning that the value of μ is high enough), This "lie to comply" option becomes unattractive to LCR-bound firms. So we do not consider this possibility in the theoretical model.

[12] The underlying parameter governing the unconstrained local content is δ_i, the firm-specific efficiency-adjusted cost of foreign content. A higher value of δ_i corresponds to a lower value of the unconstrained local content λ_i.

sector k using sector-s outputs, depends on individual prices of all firms in sector s. The LCR raises the prices of compliers by distorting their foreign sourcing decisions and the prices of non-compliers due to the non-compliance fee. The prices of composite domestic inputs also affect the sourcing and compliance decisions of all firms. The goods market clearing condition suggests that demands for outputs produced by each sector consist of intermediate input demands from other sectors and the final consumption demand.

Proposition 1 defines the two equilibria without and with the LCR. See Appendix A.1 for a detailed description of the two equilibria.

Proposition 1 (Equilibria without and with LCR)**.** *Given exogenous variables* φ_i, $z^{k,s}$, $a^k_{D,i}$, $a^k_{F,i}$, $b_{L,i}$, P^k_F, w^k, $\beta^{k,s}_D$, $X^{F,k}$, *and* $\underline{\lambda}_i$, *and parameter* θ *and* σ^s, *the equilibrium without LCR is a vector of price indexes* $\{P^{k,s}_D\}$ *that satisfies equations (A1) and (A4) for all k and s. The equilibrium with LCR is a vector of price indexes* $\{P^{k,s\prime}_D\}$ *that satisfies equation (A2), (A3) and (A5) for all k and s.*

Proposition 2 formulates the equilibrium in relative changes and investigates the impacts of the LCR when other exogenous variables (e.g., φ_i, $a^k_{D,i}$, and $a^k_{F,i}$) are fixed. See Appendix A.2 for a detailed description of the equilibrium in relative changes.

Proposition 2 (Equilibrium in relative changes)**.** *Given endogenous variables* $\{\lambda_i, \gamma_i, Y^{k,s}_i, X^{k,s}\}$, *exogenous variables* $\{X^{F,s}\}$, *policy variables* $\{\tau, \underline{\lambda}_i\}$, *and parameters* $\{\theta, \sigma^s, \beta^{k,s}_D\}$, *a relative change of the equilibrium caused by the LCR is a vector of price index changes* $\hat{P}^{k,s}_D$ *that satisfies (A3), (A6), (A7), (A8), (A9), (A10), (A11), and (A12).*

According to Proposition 2, once we calibrate and obtain the values of $\{\lambda_i, \gamma_i, Y^{k,s}_i, X^{k,s}\}$, $\{X^{F,s}\}$, $\{\tau, \underline{\lambda}_i\}$, and $\{\theta, \sigma^s, \beta^{k,s}_D\}$, we can evaluate the effects of imposing the MEMR LCR on firms and the economy.

4 Calibration

We calibrate the model to the Indonesian economy before the imposition of MEMR LCR regulation, the year of 2012. We use two main data sources. The first data source is the Indonesian manufacturing firm survey data provided by the BPS, which is already described in the previous "2.1 Data and Basic Patterns" section. The second data source is

the World Input-Output Table (WIOT), which we use to obtain the input-output coefficients and calibrate the basic features of non-manufacturing sectors. Since the upstream OG business sector mainly conducts exploration and exploitation of OG resources, it matches well with the "mining sector" in the WIOT classification. So we use the "mining sector" in the WIOT classification to define the OG sector.

4.1 Local Content and Domestic Input Share

The calculation of firm-level local content λ_i and LCR level $\underline{\lambda}_i$ for manufacturing firms has been discussed in "2.1 Data and Basic Patterns". However, since the BPS firm survey data only covers the manufacturing sector, we still need information for non-manufacturing sectors in the economy, including the agriculture sector, the OG (mining) sector, and the service sector. Because we do not have firm-level information for these three sectors, we assume that firms in these sectors are identical. The levels of local content in the agriculture, OG and service sectors in Indonesia are calibrated using the WIOT information.

For manufacturing firms, the calculation of γ_i follows (1). Similarly, we use the information in WIOT to calibrate γ_i for the agriculture, OG and service sectors in Indonesia.

4.2 Sales to Different Sectors

By definition, $Y_i^{k,s}$ is firm i's value of sales to sector k. The superscript s denotes the sector in which firm i operates. Because our model assumption indicates that the share of sales generated by sales to sector k, $S^{k,s}$, is the same across all firms in sector s, we can calculate $S^{k,s}$ for each $\{k, s\}$ pair using the information from the WIOT data, and impute firm i's sales to sector k (including sales to final consumers) as follows

$$Y_i^{k,s} = S^{k,s} \times Y_i, \tag{25}$$

where Y_i is firm i's total sales. This imputation also indicates that the market share of firm i in sector k's total input purchase from sector s is independent of k, that is, $m_i^{k,s} = m_i^s$.

Our theoretical analysis suggests that the share of sales generated by sales to the OG sector, $S^{\mathrm{OG},s}$, is critical for the firm-level compliance decisions. Table 3 shows the values of $S^{\mathrm{OG},s}$ for different supplying sector s. A larger value of $S^{\mathrm{OG},s}$ indicates that sales to

the OG sector constitutes a major revenue source for sector s, so other things being equal, firms in sector s are (on average) more likely to comply with the LCR. We notice that sales to the upstream OG generally account for a small share of the total sales for a sector s, except for the OG sector itself (17.23%). This should not be surprising given that only 4.5% of the intermediate input spending in Indonesia occurs in the OG sector. In another words, the OG sector does not appear to be a major revenue source for other sectors in the economy. The small values of $S^{OG,s}$ indicate that manufacturing firms may find it generally unattractive to distort their sourcing decisions merely to increase their sales to the OG sector, and those who do so may already be quite close to the required LCR levels so their compliance costs are small.

Table 3: Share of Sales to Upstream OG Sector

Selling sector	Share of sales to OG (%)
Agriculture	0.01
Oil & Gas	17.23
Food & Beverages	0.09
Textile & Apparel	0.14
Wood Products	0.03
Paper Products	1.04
Printing & Reproduction	0.39
Coke & Refined Petroleum	2.96
Chemicals & Medicine	2.65
Rubber & Plastic	0.08
Non-metallic Minerals	0.00
Basic Metals	0.10
Fabricated Metals	0.09
Electronic & Equipment	3.56
Motor Vehicles	1.04
Other Transportation Equipment	0.18
Other Manufacturing	1.77
Service	4.05

4.3 Production-function Parameters

We use the following formula to calibrate the elasticity of substitution σ^s for sector s:

$$\frac{\sum_{i\in\Omega^s} Y_i}{\sum_{i\in\Omega^s}(c_{D,i}M_{D,i} + c_{F,i}M_{F,i} + wL_i)} = \frac{\sigma^s}{\sigma^s - 1},$$

where Y_i is the total sales of firm i, and $c_{D,i}M_{D,i} + c_{F,i}M_{F,i} + wL_i$ is the production cost paid by firm i. Table 4 shows the calibrated value of σ^s by sector. A higher profit margin would thus translate to a lower value of σ^s.

Table 4: Calibrated Value of σ^s

Sector	σ^s
Agriculture	2.40
Oil & Gas	1.64
Food & Beverages	4.40
Textile & Apparel	3.73
Wood Products	3.46
Paper Products	4.57
Printing & Reproduction	5.55
Coke & Refined Petroleum	3.13
Chemicals & Medicine	5.12
Rubber & Plastic	7.34
Non-metallic Minerals	4.66
Basic Metals	5.04
Fabricated Metals	4.52
Electronic & Equipment	5.68
Motor Vehicles	3.39
Other Transportation Equipment	4.21
Other Manufacturing	4.24
Service	4.80

To calibrate the input-output coefficients $\beta_D^{k,s}$, we use the information from the WIOT data to compute the cost share of domestic input produced by sector s in sector-k's total domestic input expenditure. For the elasticity of substitution between local content and foreign content in the production function, we assign $\theta = 2.38$, a preferred estimate obtained by Blaum et al. (2018) using French firm-level data. The calibrated value suggests that local labor, composite domestic input and composite foreign input are substitutes. The non-compliance fee $\tau - 1$ is 0.15, consistent with the MEMR regulation.

4.4 Aggregate Domestic Input Expenditure

Finally, we need to calibrate the aggregate domestic input expenditure $X^{k,s}$, which is defined by the system of equations (A4) in the initial equilibrium before the LCR imposition. For a given purchasing sector k, $X^{k,s}/X^{k,s'} = \beta_D^{k,s}/\beta_D^{k,s'}$, so the calibration of $X^{k,s}$

boils down to finding a vector of E^k such that $X^{k,s} = \beta_D^{k,s} \times E^k$ is consistent with (A4).

To calibrate $X^{k,s}$, we first compute $X^{F,s}$, the final consumption expenditure on goods produced by sector s in Indonesia, using the WIOT data. Holding the final consumption demand $X^{F,s}$ constant, we then solve the system of equations (A4) for $X^{k,s}$.

5 Quantitative Results

In this section, we discuss the quantitative results of the LCR policy. With our calibration strategy, the model matches exactly the data in the year of 2012, the initial equilibrium without the MEMR LCR. We use the quantitative model to perform a model-based evaluation of the effects of imposing the long-term LCR targets, so we introduce the LCR into the initial equilibrium and hold fixed other exogenous variables, such as firm productivity, firm-specific cost of foreign content, and foreign input price index. Therefore, the results reported in this section should be interpreted as reflecting the pure effects of the LCR policy when other exogenous components in the model are not changed.

Since the goals of the policy are to promote usage of domestic content and to protect domestic sectors and employment, we report the compliance statuses of different manufacturing firms and their characteristics, the effects of the LCR on sales, value-added and employment, and the resulting changes in firm-level and aggregate local content. Finally, we quantify the effects of the LCR on domestic composite input costs and consumers' welfare.

5.1 Firm-level Compliance Decisions

There are three groups of firms after the LCR imposition: 1) the non-binding firms who find the LCR constraint to be non-binding, 2) the compliers who find the LCR constraint binding and decide to comply with the regulation, and 3) the non-compliers who also find the LCR constraint binding but decide not to comply with the regulation. Table 5 shows the number of firms falling into each category. The last row of Table 5 shows that over 93% $(19,663/(19,663+95+1,320))$ of manufacturing firms find the LCR to be non-binding. For the remaining 7% who find the LCR to be binding, only about 7% $(95/(95+1,320))$ of them choose to comply with the LCR. We also find that the shares

of firms falling into different compliance statuses vary by sector. A very tiny fraction of firms in the sectors of "Food & Beverage", "Wood Products" and "Printing & Reproduction" find the LCR binding because sales to the upstream OG sector only account for a very small fraction of their total sales. The LCR is more binding for firms in the sectors of "Coke & Refined Petroleum", "Chemicals & Medicine", "Basic Metals", "Fabricated Metals", "Electronic & Equipment", "Motor Vehicles" and "Other Transportation Equipment", where more firms exhibit stronger dependence on foreign inputs and lower local content. Finally, while the vast majority of the firms constrained by LCR choose not to comply, in the "Chemicals & Medicine" and "Electronic & Equipment" sectors, there are 13% of the LCR-bound firms comply with the regulation. As shown in Table 3, these are two manufacturing sectors that generate relatively larger fractions of their revenues from sales to the upstream OG sector (2.56% and 3.56% respectively).

Table 5: Firm-level Compliance Decisions

Sector	Number of:		
	Non-binding firms	Compliers	Non-compliers
Food & Beverages	6,655	6	111
Textile & Apparel	3,648	7	255
Wood Products	999	0	16
Paper Products	412	0	35
Printing & Reproduction	455	0	6
Coke & Refined Petroleum	59	0	8
Chemicals & Medicine	835	28	190
Rubber & Plastic	1,427	1	125
Non-metallic Minerals	1,553	0	57
Basic Metals	184	0	57
Fabricated Metals	651	6	93
Electronic & Equipment	567	29	189
Motor Vehicles	217	4	46
Other Transportation Equipment	166	2	49
Other Manufacturing	1,835	12	83
All	19,663	95	1320

What are the characteristics of the firms constrained by the LCR? We examine this question by comparing the characteristics of firms with different compliance statuses, as shown in Table 6. First, we notice that compliers and non-compliers are on average much larger than non-binding firms. While the average market share (defined as firm-

level sales divided by the sales of all firms in the same sector) of compliers and non-compliers before the LCR imposition are 0.27-0.28%, the average market share of non-binding firms before the LCR imposition is only 0.07%. Moreover, LCR-bound firms use imported inputs more intensively than non-binding firms. As shown in the second row of Table 6, the average local content (domestic input and labor cost divided by total input and labor cost) of non-binding firms before the LCR imposition is 96.9%, while the average local content of compliers and non-compliers before the LCR imposition are 37.1% and 11.9%, respectively. So LCR-bound firms are larger and import much more than non-binding firms to begin with, and non-compliers rely on foregin inputs more than compliers. Intuitively, firms better at using imported inputs are affected by the LCR more than firms that barely use imported inputs. Among these firms, those who import relatively less find it easier to comply with the regulation.

Table 6: Firm Characteristics by Compliance Status

Firm type:	Compliers	Non-binding firms	Non-compliers
Before LCR imposition:			
Average market share per firm (%)	0.27	0.07	0.28
Average local content (%)	37.1	96.9	11.9
After LCR imposition:			
Average change in unit cost (%)	0.04	0.07	0.01
Average cost penalty κ	1.00	1	1.24

The imposition of the LCR affects all firms by raising their domestic input costs. The third row of Table 6 shows the average change in unit cost, $\hat{C}_i$, without taking into account either the cost penalties due to distorted sourcing decisions or the non-compliance fees. The effects are quite small. On average, the unit costs of non-binding firms increase by 0.07%, while the unit costs of compliers and non-compliers increase by 0.04% and 0.01%, respectively. Non-binding firms suffer relatively more from the rising domestic input costs because most of their inputs are sourced domestically.

The last row of Table 6 shows the average cost penalties, κ_i, for different types of firms were they choose to comply with the LCR, i.e., the cost of compliance. A value of $\kappa = 1$ indicates no cost penalty. Since the non-binding firms can comply with the LCR without changing their foreign sourcing decisions, their cost penalties are by definition

equal to 1. We find that the average cost penalty of compliers is also extremely close to 1,[13] indicating that their "unconstrained" local content is only slightly lower than the one required by the LCR. In fact, the average local content of compliers before the LCR imposition is 37.1%, very close to the level of LCR faced by most firms (40%). In this case, it makes sense for these firms to slightly distort their sourcing decisions just to avoid the non-compliance fee of selling to the upstream OG sector. For non-compliers, the cost penalty of distorting their sourcing decisions to meet the LCR is substantial. The average κ for non-compliers is 1.24, meaning that on average, complying with the LCR would inflate these firms' unit cost by about 24% and seriously undermine their cost competitiveness. Notice that the average local content of the non-compliers before the LCR imposition is only 11.9%, so the cost to comply for these firms are significant, inducing them to give up compliance.

To summarize, we find that larger firms that use imported inputs more intensively are more likely to be constrained by the LCR. Among these LCR-bound firms, those that import relatively more are less likely to comply with the LCR.

5.2 The Impacts on Sales, Value-added and Employment

We examine the impacts of the MEMR LCR on firm-level and aggregate outcomes. A failure to comply with the LCR results in a firm being charged a non-compliance fee of 15% when selling to the upstream OG sector, so we first examine sales to non-OG sector and OG sector separately. Table 7 shows the results. Sales to non-OG sector are almost not affected by the LCR, as the average changes in sales to the non-OG sector are -0.5%, -0.2% and 0.1% for compliers, non-binding firms and non-compliers, respectively.

[13] In fact, the average cost penalty of compliers is 1.00125, so it appears 1.00 when being rounded to two decimal places.

Table 7: Changes in Sales to Different Sectors

Firm type:	Compliers	Non-binding firms	Non-compliers
		To non-OG sector:	
Average change in sales (%)	-0.5	-0.2	0.1
Change in total sales (%)	-0.2	-0.3	0.1
		To OG sector:	
Average change in sales (%)	13.3	5.8	-34.0
Change in total sales (%)	14.6	0.1	-24.3

Significant changes and reallocation appear in the sales to the OG sector. First, as shown in the third row of Table 7, non-compliers suffer an average decline of their sales to the OG sector by 34.0%, caused by the non-compliance fee. Second, both compliers and non-binding firms increase their market shares in the OG sector after the LCR imposition. On average, compliers and non-binding firm experience an increase of their sales to the OG sector by 13.3% and 5.8% respectively. The last row of Table 7 shows the changes in total sales of each firm type. The total sales to the OG sector of non-compliers decrease by 24.3%, while the total sales to the OG sector of compliers increase by 14.6%. So the LCR does cause substantial responses of sales to the OG sector.

Next, we examine the change of firm-level sales, value-added and employment for different firm types. Firm-level sales sum up a firm's sales to the non-OG and the OG sector. The uppper panel of Table 8 shows the results. The average change in firm-level sales for all types of firms is about -0.2%. Likewise, the average changes in firm-level value-added are also small, ranging from -0.2% to 0.1%. Such small effects can be explained by the fact that on average, sales to the OG sector only account for a small fraction of a typical manufacturing firm's total sales (see Table 3). Turning to the employment effects, we find that the average change in firm-level employment of compliers is 8%. Such an increase is due to compliers' increases in their local content, which include the labor they hire, to the LCR levels. In contrast, non-binding firms and non-compliers see very limited average changes in their employments. We observe similar patterns when aggregating sales, value-added and employment for different firm types: Only the total employment of compliers exhibits a significant increase due to the compliance decisions, while other variables experience very small changes.

The lower panel of Table 8 shows that the LCR imposition leads to declines in total

sales, total value-added and total employment in the whole economy by 0.2%, 0.2% and 0.1%, respectively. The aggregate effects are hence small. The effects on the OG sector are slightly more significant, causing its total OG sales and value-added to decrease by 0.5% and 0.4% and its total employment to increase by 0.1%.

Table 8: Changes in Sales and Value-added

Firm type:	Compliers	Non-binding firms	Non-compliers
Average change in:			
Firm-level sales (%)	-0.2	-0.2	-0.2
Firm-level value-added (%)	0.1	-0.2	-0.2
Firm-level employment (%)	8.0	-0.1	-0.2
Change in:			
Total sales (%)	0.1	-0.2	-0.1
Total value-added (%)	0.1	-0.2	-0.1
Total employment (%)	10.8	-0.1	-0.2
		All firms	
Change in the whole economy:			
Total sales (%)		-0.2	
Total value-added (%)		-0.2	
Total employment (%)		-0.1	
Change in the OG sector:			
Total sales (%)		-0.5	
Total value-added (%)		-0.4	
Total employment (%)		0.1	

An important motivation to impose LCR is to increase the usage of local content. So we also examine the changes in average and aggregate local content. The results are shown in Table 9. For comparison, we report the local content levels both before and after the LCR imposition ("without LCR" and "with LCR"). Columns 1 and 2 are average local content of different firm types. On average, the LCR imposition causes the average local content of compliers to increase from 37.13% to 40%. As indicated by the theoretical analysis, compliers choose the exact level required by the LCR to minimize the compliance cost. Since the level of LCR faced by most manufacturing firms is 40%, the average local content also settles at the 40% level.

Table 9: Changes in Firm-level and Aggregate Local content

	(1)	(2)	(3)	(4)
	Avg. local content (%)		Agg. local content (%)	
Firm type:	*without LCR*	*with LCR*	*without LCR*	*with LCR*
Compliers	37.13	40.00	36.09	40.00
Non-binding firms	96.92	96.91	91.01	91.00
Non-compliers	11.92	11.91	11.69	11.66
The whole economy			83.96	83.95
OG sector			87.91	87.83

Non-binding firms and non-compilers both experience a slight decrease in their average local content, as shown in Table 9 Columns 1 and 2. Although the decline in local content is quantitatively small and could be considered insignificant, the fact that firms are reducing their local content implies an unintended consequence of imposing a local content requirement induced by general equilibrium. Because the LCR restricts the use of imported inputs, it often leads to higher prices for domestic producers. If other domestic firms rely on the outputs of these producers, the cost of domestic inputs will also increase. Non-binding firms and non-compilers face higher costs for domestic inputs, which may discourage their use of these inputs, resulting in a decrease in their local content.

Changes in the aggregate local content of different firm types, as shown in Table 9 Columns 3 and 4, reveal that the increase in local content of compliers is counterbalanced by the small decrease in local content of more numerous non-binding firms and non-compliers. Consequently, the overall local content in the economy and the local content in the OG sector remain almost unchanged. The slight decline in local content resulting from higher domestic input costs outweighs the increase in local content resulting from compliance. While the overall impact of Indonesia's MEMR LCR appears negligible, this general equilibrium effect could potentially undermine the policy's original intent if the LCR were more binding and extensive.

5.3 The Impacts on Prices and Welfare

We conclude the quantitative analysis by reporting the effects of the LCR imposition on aggregate prices and consumers' welfare. The previous results about changes in local content indicate that the LCR increases domestic input costs. Since the non-compliance

fee only applies to sales to the OG sector, Table 10 shows the changes in the aggregate price indexes of goods sold to non-OG sectors and to OG sector separately. For example, the fourth row of Table 10 shows that the aggregate price index of goods produced by the "Textile & Apparel" sector and sold to the non-OG sectors increases by 0.03%, while the aggregate price index of goods produced by the "Textile & Apparel" sector and sold to the OG sectors increases by 3.98%.

Table 10: Changes in Price Indexes of Goods Sold to Different Sectors

	(1)	(2)
Change in price index (%):	To non-OG	To OG
Selling sector:		
Agriculture	0.01	0.01
Oil & Gas	0.44	0.44
Food & Beverages	0.02	0.75
Textile & Apparel	0.03	3.98
Wood Products	0.04	0.65
Paper Products	0.05	1.19
Printing & Reproduction	0.05	0.24
Coke & Refined Petroleum	0.21	6.46
Chemicals & Medicine	0.13	3.96
Rubber & Plastic	0.06	0.61
Non-metallic Minerals	0.19	2.86
Basic Metals	0.16	5.64
Fabricated Metals	0.12	4.07
Electronic & Equipment	0.04	4.15
Motor Vehicles	0.06	4.34
Other Transportation Equipment	0.03	5.32
Other Manufacturing	0.06	2.03
Service	0.05	0.05

Looking across different sectors, we find that the price increases of goods sold to the OG sector are much larger than the price increases of goods sold to the non-OG sectors. In particular, the prices of goods produced by "Coke & Refined Petroleum", "Basic Metals", "Other Transportation Equipment", "Motor Vehicles", "Electronic & Equipment", and "Fabricated Metals" all increase by more than 4%. The significant increases of prices of goods sold to the OG sector are mostly due to the non-compliance fees paid by the non-compliers.

On the other hand, prices of goods sold to the non-OG sectors all increase by less than 0.5%, so these prices are only slightly affected by the LCR imposition.

Table 11 shows the changes in the domestic input costs faced by different sectors. The domestic input cost faced by a firm in sector k is a weighted-average of domestic price indexes across all sectors weighted by $\beta_D^{k,s}$. The parameter $\beta_D^{k,s}$ describes the intensity at which goods produced by sector s are used as inputs in the production of sector k. As shown in Table 11 Column 1, the effects of the LCR imposition on domestic input costs are generally quite small. Not surprisingly, the "Oil & Gas" sector experiences the largest increase in its domestic input cost (0.79%) because the LCR targets the goods supplied to this sector. The "Coke" & Petroleum" sector see the second largest increase in its domestic input cost (0.39%) due to its heavy reliance on the OG goods as its inputs. Table 11 Column 2 also shows the "tradeable" domestic input costs, which only concern the non-service inputs. The effects on the domestic tradeable input costs are usually larger. For instance, the domestic tradeable input cost of the "Oil & Gas" sector increases by 1.29%.

Table 11: Changes in Domestic Input Costs and Consumer Price

	(1)	(2)
	Change in domestic input cost (%)	
Sector	All inputs	Tradeable inputs
Agriculture	0.04	0.04
Oil & Gas	0.79	1.29
Food & Beverages	0.02	0.02
Textile & Apparel	0.06	0.06
Wood Products	0.04	0.04
Paper Products	0.06	0.06
Printing & Reproduction	0.06	0.08
Coke & Refined Petroleum	0.39	0.43
Chemicals & Medicine	0.20	0.26
Rubber & Plastic	0.08	0.09
Non-metallic Minerals	0.26	0.35
Basic Metals	0.28	0.36
Fabricated Metals	0.20	0.28
Electronic & Equipment	0.05	0.06
Motor Vehicles	0.06	0.07
Other Transportation Equipment	0.06	0.07
Other Manufacturing	0.07	0.10
Service	0.10	0.15
	Change in domestic price (%)	
	All goods	Tradeable goods
Final Consumption	0.04	0.04

Finally, we examine the effect of the LCR imposition on domestic price faced by Indonesian consumers. The change in domestic consumer price is a Cobb-Douglas weighted-average of the price changes of different sectors shown in Table 11, where the Cobb-Douglas weights are the expenditure shares of each sector in the final consumption. The last row of Table 11 shows the results. The changes in aggregate consumer prices of all goods and tradeable goods are both about 0.04%.

Overall, the LCR imposition causes significant increases only in the prices of goods supplied to the upstream OG sector but has very limited impacts on prices of goods supplied to the other sectors. The resulting increases in domestic input costs and consumer prices are also quite small.

6 Conclusions

In this chapter, we develop a model to quantify the impacts of local content requirements (LCRs). We focus on Indonesia's LCR regulation that promotes the use of domestic content in its upstream OG sector. We introduce the LCR compliance decisions faced by manufacturing firms into the foreign sourcing model developed by Blaum et al. (2018). An LCR-bound firm weighs the cost penalty of complying with LCR and the non-compliance cost to make its compliance decision. Domestic price indexes are affected by LCR in the equilibrium, so firms that are not bound by LCR also adjust their local content.

We calibrate the model to the Indonesian economy and quantify the impacts of the LCR regulation. The LCR causes substantial responses and reallocation of firm-level sales to the OG sector, but yields only small effects on aggregate sales, value-added, and employment. Although the LCR imposition induces the average local content of compliers to increase, it also raises costs of domestic inputs and leads to declines in the local content of non-binding firms and non-compliers, resulting in a slightly lower aggregate local content. Therefore, an attempt to increase aggregate local content by imposing LCR may result in unintended consequences.

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A Appendix: Describing the Full Equilibrium

A.1 Equilibria with and without LCR

In the equilibrium without LCR, the domestic price index of composite input purchased by sector k from sector s, $Q_D^{k,s}$, is given by

$$P_D^{k,s} = \frac{\sigma^s}{\sigma^s - 1}\Big[\sum_{i\in\Omega^s}\Big(\frac{C_i^s}{z^{k,s}}\Big)^{1-\sigma^s}\Big]^{\frac{1}{1-\sigma^s}}. \tag{A1}$$

In contrast, the same price index in the equilibrium with LCR is given by:

$$\begin{aligned}
P_D^{k,s\prime} &= \frac{\sigma^s}{\sigma^s - 1}\Big[\sum_{i\in\Omega^s_{\text{NB}}\cup\Omega^s_{\text{C}}}\Big(\frac{C_i^{s\prime}}{z^{k,s}}\Big)^{1-\sigma^s} + \sum_{i\in\Omega^s_{\text{NC}}}\Big(\frac{\tau C_i^{s\prime}}{z^{k,s}}\Big)^{1-\sigma^s}\Big]^{\frac{1}{1-\sigma^s}}, \;\; k = \text{OG} \\
P_D^{k,s\prime} &= \frac{\sigma^s}{\sigma^s - 1}\Big[\sum_{i\in\Omega^s}\Big(\frac{C_i^{s\prime}}{z^{k,s}}\Big)^{1-\sigma^s}\Big]^{\frac{1}{1-\sigma^s}}, \;\; k \neq \text{OG}, F \\
P_D^{k,s\prime} &= \frac{\sigma^s}{\sigma^s - 1}\Big[\sum_{i\in\Omega^s}\Big(\frac{C_i^{s\prime}}{z^{k,s}}\Big)^{1-\sigma^s} + \sum_{i\in\Omega^{s*}}\Big(\frac{C_i^{s}}{z^{k,s}}\Big)^{1-\sigma^s}\Big]^{\frac{1}{1-\sigma^s}}, \;\; k = F
\end{aligned} \tag{A2}$$

where Ω^s_{NB}, Ω^s_{C} and Ω^s_{NC} denote the sets of firms that find their LCR non-binding, firms that decide to comply with their binding LCR, and firms that decide not to comply, respectively. We can characterize the compliance decision of firm i based on

$$i \in \begin{cases} \Omega^s_{\text{NB}}{}', \;\; \text{if } \lambda_i' \geq \underline{\lambda}_i, \\ \Omega^s_{\text{C}}{}', \;\; \text{if } \lambda_i' < \underline{\lambda}_i \;\text{ and }\; S^{\text{OG},s\prime} > \frac{1-\kappa_i'^{1-\sigma^s}}{1-\tau^{1-\sigma^s}}, \\ \Omega^s_{\text{NC}}{}', \;\; \text{if } \lambda_i' < \underline{\lambda}_i \;\text{ and }\; S^{\text{OG},s\prime} \leq \frac{1-\kappa_i'^{1-\sigma^s-1}}{1-\tau^{1-\sigma^s}}, \end{cases} \tag{A3}$$

where

$$\hat{S}^{\text{OG},s} = \frac{\Gamma^{\text{OG},s\prime}(z^{\text{OG},s})^{\sigma^s-1}}{\sum_k \Gamma^{k,s\prime}(z^{k,s})^{\sigma^s-1}} = \frac{\hat{\Gamma}^{\text{OG},s}}{\sum_k S^{k,s}\hat{\Gamma}^{k,s}},$$

and $\hat{\Gamma}^{k,s} = (\hat{P}_D^{k,s})^{\sigma^s-1}\hat{X}^{k,s}$.

Input demands for goods produced by sector s depend on the sizes of other sectors k and the input-output linkage between k and s. Meanwhile, we assume that the final

consumption expenditures $X^{F,s}$ are fixed. So the input market clearing condition is

$$X^{k,s} = \beta_D^{k,s}\Big[\sum_{i\in\Omega^k}\sum_n \lambda_i\gamma_i\Big(\frac{\sigma^k-1}{\sigma^k}\Big)^{\sigma^k}\Big(\frac{C_i}{z^{n,k}}\Big)^{1-\sigma^k}(P_D^{n,k})^{\sigma^k-1}X^{n,k}\Big], \tag{A4}$$

and

$$\begin{aligned} X^{k,s\prime} =& \beta_D^{k,s}\Big[\sum_{i\in\Omega^k}\sum_{n\neq \mathrm{OG}} \lambda_i'\gamma_i'\Big(\frac{\sigma^k-1}{\sigma^k}\Big)^{\sigma^k}\Big(\frac{C_i'}{z^{n,k}}\Big)^{1-\sigma^k}(P_D^{n,k\prime})^{\sigma^k-1}X^{n,k\prime}\Big] \\ &+\beta_D^{k,s}\Big[\sum_{i\in\Omega^k_{\mathrm{NC}}} \lambda_i'\gamma_i'\Big(\frac{\sigma^k-1}{\sigma^k}\Big)^{\sigma^k}\Big(\frac{\tau C_i'}{z^{\mathrm{OG},k}}\Big)^{1-\sigma^k}(P_D^{\mathrm{OG},k\prime})^{\sigma^k-1}X^{\mathrm{OG},k\prime}\Big] \\ &+\beta_D^{k,s}\Big[\sum_{i\in\Omega^k_{\mathrm{NB}}\cup\Omega^k_{\mathrm{C}}} \lambda_i'\gamma_i'\Big(\frac{\sigma^k-1}{\sigma^k}\Big)^{\sigma^k}\Big(\frac{C_i'}{z^{\mathrm{OG},k}}\Big)^{1-\sigma^k}(P_D^{\mathrm{OG},k\prime})^{\sigma^k-1}X^{\mathrm{OG},k\prime}\Big] \end{aligned} \tag{A5}$$

Combining the conditions above, we can define the two equilibria without and with the LCR.

Proposition 1 (Equilibria without and with LCR)**.** *Given exogenous variables φ_i, $z^{k,s}$, $a^k_{D,i}$, $a^k_{F,i}$, $b_{L,i}$, P_F^k, w^k, $\beta_D^{k,s}$, $X^{F,k}$, and $\underline{\lambda}_i$, and parameter θ and σ^s, the equilibrium without LCR is a vector of price indexes $\{P_D^{k,s}\}$ that satisfies equations (A1) and (A4) for all k and s. The equilibrium with LCR is a vector of price indexes $\{P_D^{k,s\prime}\}$ that satisfies equation (A2), (A3) and (A5) for all k and s.*

A.2 Equilibrium in Relative Changes

We investigate the impacts of the LCR imposition by formulating the equilibrium in relative changes. The relative change of price index is:

$$
\begin{aligned}
(\hat{P}_D^{k,s})^{1-\sigma^s} &= \sum_{i\in\Omega^s_{\text{NB}}} m_i^{k,s}\left[\hat{P}_D^s\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}\right]^{1-\sigma^s} + \sum_{i\in\Omega^s_{\text{C}}} m_i^{k,s}\left[\hat{P}_D^s\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}\kappa_i'\right]^{1-\sigma^s} \\
&\quad + \sum_{i\in\Omega^s_{\text{NC}}} m_i^{k,s}\left[\hat{P}_D^s\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}\tau\right]^{1-\sigma^s}, \quad k=\text{OG}, \\
(\hat{P}_D^{k,s})^{1-\sigma^s} &= \sum_{i\in\Omega^s_{\text{NB}}\cup\Omega^s_{\text{NC}}} m_i^{k,s}\left[\hat{P}_D^s\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}\right]^{1-\sigma^s} + \sum_{i\in\Omega^s_{\text{C}}} m_i^{k,s}\left[\hat{P}_D^s\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}\kappa_i'\right]^{1-\sigma^s}, \quad k\neq\text{OG},F \\
(\hat{P}_D^{k,s})^{1-\sigma^s} &= \sum_{i\in\Omega^s_{\text{NB}}\cup\Omega^s_{\text{NC}}} m_i^{k,s}\left[\hat{P}_D^s\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}\right]^{1-\sigma^s} + \sum_{i\in\Omega^s_{\text{C}}} m_i^{k,s}\left[\hat{P}_D^s\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}\kappa_i'\right]^{1-\sigma^s} \\
&\quad +(1-\sum_{i\in\Omega^{s*}} m_i^{k,s}), \quad k=F,
\end{aligned}
\tag{A6}
$$

where $m_i^{k,s}=Y_i^{k,s}/X^{k,s}$ is the market share of firm i in sector k's total input purchase from sector s, or the market share of firm i in the final consumption demand. The change in output prices of non-binding firms arises from the general equilibrium effect that affects the domestic composite input prices. For instance, non-binding firms reduce domestic input usages when the domestic composite input prices increase. In addition to the general equilibrium effect, the compliance cost penalties κ_i' directly inflate the output prices of the complying firms. Meanwhile, non-compliers are charged an *ad valorem* non-compliance fee of τ when selling to the upstream OG sector, which also increases their prices.

According to the Cobb-Douglas formulation, the relative change in the cost of domestic composite input is

$$\hat{P}_D^s=\Pi_n(\hat{P}_D^{s,n})^{\beta_D^{s,n}}. \tag{A7}$$

Looking into the change in the local content $\hat{\lambda}_i$ of firm i and assuming that foreign

composite input cost P_F^k is not affected by the LCR, we notice that

$$\hat{\lambda}_i = \frac{[\gamma_i(\hat{P}_D^k)^{1-\theta} + (1-\gamma_i)]^{\frac{1-\theta}{1-\theta}}}{\lambda_i[\gamma_i(\hat{P}_D^k)^{1-\theta} + (1-\gamma_i)]^{\frac{1-\theta}{1-\theta}} + (1-\lambda_i)}, \tag{A8}$$

which depends on $\hat{P}_D^k$ given λ_i, γ_i, and θ. Hence we can get $\lambda_i' = \hat{\lambda}_i\lambda_i$. With λ_i' in hand, we can also calculate κ_i':

$$\kappa_i' = \left[\underline{\lambda}(\frac{\lambda_i'}{\underline{\lambda}})^{\frac{1}{\theta}} + (1-\underline{\lambda})(\frac{1-\lambda_i'}{1-\underline{\lambda}})^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\theta}}. \tag{A9}$$

The change in domestic input share within firm i's local content is

$$\hat{\gamma}_i = \frac{(\hat{P}_D^k)^{1-\theta}}{\gamma_i(\hat{P}_D^k)^{1-\theta} + (1-\gamma_i)}. \tag{A10}$$

So we can rewrite the relative change in firm-level unit cost as

$$\hat{C}_i = \begin{cases} \hat{P}_D^k\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}, & \text{if } i \in {\Omega_{\text{NC}}^k}' \cup {\Omega_{\text{NB}}^k}' \\ \kappa_i\hat{P}_D^k\hat{\gamma}_i^{\frac{1}{\theta-1}}\hat{\lambda}_i^{\frac{1}{\theta-1}}, & \text{if } i \in {\Omega_{\text{C}}^k}' \end{cases} \tag{A11}$$

The total expenditure on domestic input in the LCR equilibrium can be written as:

$$\begin{aligned} X^{k,s}\hat{X}^{k,s} =& \beta_D^{k,s}\frac{\sigma^k-1}{\sigma^k}\Big[\sum_{i\in\Omega^k}\sum_{n\neq\text{OG}}\lambda_i'\gamma_i'Y_i^{n,k}\hat{C}_i^{1-\sigma^k}\hat{P}_D^{n,k\sigma^k-1}\hat{X}^{n,k} \\ &+\tau^{1-\sigma^s}\sum_{i\in\Omega_{\text{NC}}^k}\lambda_i'\gamma_i'Y_i^{\text{OG},k}\hat{C}_i^{1-\sigma^k}\hat{P}_D^{\text{OG},k\sigma^k-1}\hat{X}^{\text{OG},k} \\ &+\sum_{i\in\Omega_{\text{NB}}^k\cup\Omega_{\text{C}}^k}\lambda_i'\gamma_i'Y_i^{\text{OG},k}\hat{C}_i^{1-\sigma^k}\hat{P}_D^{\text{OG},k\sigma^k-1}\hat{X}^{\text{OG},k}\Big], \end{aligned} \tag{A12}$$

which helps to define $\hat{X}^{k,s}$ given other variables. The following proposition describes the relative change of the equilibrium caused by the LCR imposition.

Proposition 2 (Equilibrium in relative changes)**.** *Given endogenous variables* $\{\lambda_i, \gamma_i, Y_i^{k,s}, X^{k,s}\}$*, exogenous variables* $\{X^{F,s}\}$*, policy variables* $\{\tau, \underline{\lambda}_i\}$*, and parameters* $\{\theta, \sigma^s, \beta_D^{k,s}\}$*, a relative change of the equilibrium caused by the LCR is a vector of price index changes* $\hat{P}_D^{k,s}$ *that satis-*

fies (A3), (A6), (A7), (A8), (A9), (A10), (A11), and (A12).

Once we calibrate and obtain the values of $\{\lambda_i, \gamma_i, Y_i^{k,s}, X^{k,s}\}$, $\{X^{F,s}\}$, $\{\tau, \underline{\lambda}_i\}$, and $\{\theta, \sigma^s, \beta_D^{k,s}\}$, we can evaluate the effects of imposing the MEMR LCR on firms and the economy.