Price Shocks and Labor Mobility: Theory and Evidence from Indonesia

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Abstract

I develop a specific-factor model in a multi-region small open economy framework with labor mobility to understand the impact of exogenous terms-of-trade shocks. I follow Redding (2016) in modeling asymmetric locations of which workers have heterogeneous preferences on amenities of each region. Unlike most studies on the impact of trade to labor, this enviroment relaxes the assumption on inelastic or perfectly elastic labor supply by generalizing labor supply curve that allows upward-sloping curve. Then, I bring the prediction of the model to the impact of the global commodity boom in the 2000s to the Indonesian economy. This study finds evidences supporting the prediction that higher contribution of commodity sector to a region is associated with higher increase in the region's average earnings.

For correspondence, please contact: rsiregar@ucdavis.edu. This paper is preliminary. Please do not cite. Thank you.

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1 Introduction

Most trade models predict that trade can make a country better off despite the redistribution of benefits and losses across different factor owners. Yet, these predictions are based on models that tend to emphasize full factor mobility within countries[1]. Some studies have emphasized that the dynamic of this redistribution is not as straightforward as one thinks. The study on the impact of Chinese import competition on US local labor markets by Autor et al. (2013) and the impact of trade liberalization in Brazil by Dix-Carneiro and Kovak (2017) show that both sectoral and spatial labor reallocation are sluggish. This research aims to contribute to this particular discussion on the distributional impacts from participation in international trade. Specifically, it studies the impact of trade in a small-open-economy context and medium-run framework when it is common to have some degree of specificity of factors in each sector, as well as some rigidity in the movement of labor.

In order to study the impact of trade with some movement of factors, we need an exogenous shock due to trade. Much unilateral trade liberalization occured decades ago as countries joined the GATT and later the WTO. Even if we use trade liberalization as shock, there is always a challenge in getting pure exogeneous unilateral trade policies as many trade liberalization process run through the political process and hence likely to be endogeneous. Here, we take the global commodity boom of the 2000s as an exogeneous shock[2] for a small open economy, as it widely affected (primary) commodities producers and yet it was driven by external factors from the perspective of commodities producers.[3] Specifically, Indonesia is chosen as the object of study as it provides an appropriate environment to study a small-open economy with multi-regional differences in comparative advantage. It has relatively high quality datasets that allows one to minimize problems due to measurement error or inconsistency across survey years.

Table 1 shows a stylized fact that motivates this study. It shows that during the decade of the 2000s there has been changes in the dispersion of expenditure per capita as a proxy of income per capita across districts in Indonesia. We can see relatively a large drop in interregional

[1] An exception is the work of Artuç et al. (2010).
[2] Other researches using global commodity boom as exogeneous shock include Adão (2015).
[3] See Haniotis and Baffes (2010) for discussion.

inequality between 2005 and 2011, which coincides with the period of global commodity boom. As a comparison, Shenoy (2016) computes that the ratio of standard deviation to median of average wages across provinces in Thailand in the 1980's and 1990's was around 0.5. This number from Thailand for the earlier period is higher than in Indonesia in more recent periods. Yet as Shenoy (2016) studies, Thailand was in an environment of relatively high migration costs across regions, which as he argues, is one of the reasons of the high interregional inequality.

Table 1: Trend of Interregional Inequality in Indonesia

Year	90/10 ratio	50/10 ratio	s.d/median
2002	2.30	1.37	0.45
2005	2.92	1.44	0.56
2008	2.40	1.47	0.39
2011	2.22	1.41	0.37
2014	2.27	1.39	0.40
2016	2.13	1.33	0.36

Source: calculated from SUSENAS 2002, 2005, 2008, 2011, 2014, 2016.

As shown in Table 2 below, convergence in the period between 2005 and 2011 is relatively faster than the more recent period between 2011 and 2016. We see some convergence in both periods as shown in Figure 1 and 2, yet disparity persists as shown in Figure 6 and 7 in Appendix B.

Table 2: Convergence and Growth

Period	Growth of Real Expenditure per Capita
2005 - 2011	-0.39 (0.024)
2011 - 2016	-0.17 (0.022)

Notes: Each cell represents the coefficient for regression of growth of real expenditure per capita on inital log real expenditure per capita with standard error in parentheses. Regressions are run separately for each period and include a constant. Units of observation are districts.

Figure 1: Convergence in 2005-2011

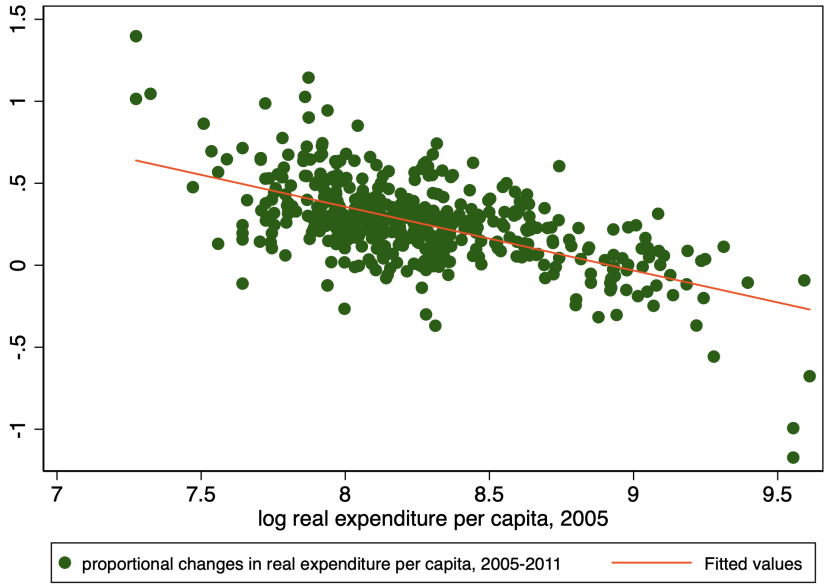
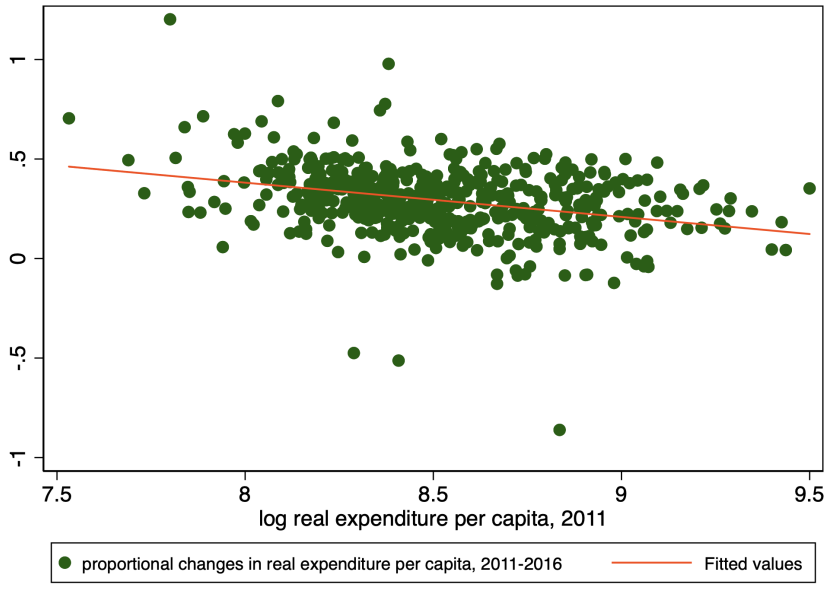


Figure 2: Convergence in 2011-2016



This study aims to answer how exogeneous price shocks affect changes in income in different regions with different comparative advantage, driven by their relative endowment in immobile factors. This research also aims to understand the impact of exposure to Terms of Trade shock to interregion inequality. Understanding inequality is important as it affects the political process and further affects policy.

Unlike the approach taken in much of the literature, we relax the assumption that regions face perfectly inelastic or perfectly elastic labor supply. Following Redding (2016), we set up a theoretical model with upward labor supply faced by each region in the economy. We futher allow labor to move across regions while letting them to have hetereogenous preferences on amenities, provided exogeneously by each region. The model predicts that for a given price change, the increase in income depends on the share of population of the region, the level of amenities, and the share of booming sector in the economy. Armed with this prediction, we then use Indonesian data to test it empirically and find preliminary support for the prediction.

This paper begins with literature review on related topics in Section 2. Section 3 explains the theoretical model and Section 4 presents empirical results. Section 5 completes the paper with the plans ahead.

2 Literature Review

Goldberg and Pavcnik's (2007) survey on the impact of trade on labor markets in the context of developing economies shows various challenges to understand the channels between globalization and the domestic distribution of gains or losses from international trade, both theoretically and empirically. Empirical work has been especially difficult as data availability and quality in developing world may not be sufficient to draw causal inference between trade and the distribution of gains from trade. Nevertheless, since this survey paper has been released 10 years ago, more studies have shown how trade shocks may affect local economies and how the distribution of gains or losses from such shocks propagates. This was fueled in part by the availability of better datasets in developing countries and more attention to the impact of trade on labor market, especially in short and medium run. The following literature review will cover four big topics related to the research. They are: the trade impact on labor market; the Dutch Disease; spatial economics; and information frictions in trade.

2.1 Trade Impact on Labor Markets

The classic interpretation on the distributional impact of opening up to trade is the Stolper-Samuelson Theorem, stating that the abundant factor would gain from trade while the scarce factor loses. Nevertheless, as shown by Goldberg and Pavcnik (2007), it has been challenging to rationalize the prediction of Stolper-Samuelson Theorem with what we see in the real world, especially in developing economies. They discuss some features that most studies have found that attribute the results to little evidence in support of full labor-mobility across sector, which is one of Stolper-Samuelson's (and Heckscher-Ohlin model) main ingredients. These features include rigid labor markets, existence of imperfect product markets and very low spatial (and social) mobility. This sluggish labor reallocation across sector seem not only to exist in the developing world. In US labor market, which can be argued to have less rigid labor market and more fluid spatial labor mobility, Artuç et al. (2010) estimate that the costs of cross-sector mobility may reach several times of average annual earnings.

Motivated by little evidence in the favor of the long-run view of trade and its predictions, a stream of literature on the trade impact on labor markets resorts to a more short-run or medium-run framework, in which one or more factors are immobile across sectors or regions. To be precise, this literature applies and extends the Specific-Factor model to analyze distributional impact of trade. In this group of literature, some studies focus on the Terms of Trade (ToT) shock in the form of changes in relative price due to trade liberalization, such as Kovak (2013) and Dix-Carneiro and Kovak (2017), or other types of relative price shock including the global commodity boom as in Adão (2015)[4]. As mentioned by Kovak (2013), the specific-factor model of regional economies is driven by relative price changes across industries. Thus, this framework is suitable in understanding how regions respond to exogenous price shock, be it due to unilateral changes in tariffs or other changes in world price. Both Kovak (2013) and Dix-Carneiro and Kovak (2017) explore variation across regions that stems from industrial variation. They show that despite all regions facing a uniform price shock, exposure to the shock varies as each region has different industrial composition. A similar approach is taken in this research, too, in which regions face a

[4]Another stream of literature includes exposure to import competition such as Autor et al. (2013).

uniform price shock yet vary in regard to the exposure to shocks. The research further relaxes the assumption of full immobility across labor markets, as will be explained further in the subsection on spatial economics. We argue that a ToT shock is a relevant exogeneous shock to many developing countries, and the extent of the recent global commodity boom is long enough to allow some factor mobility.

2.2 Dutch Disease and Sectoral Adjustment

The Dutch Disease is a phenomenon where a country's tradable sector shrinks due to growth of another tradable sector.[5] Inspired by its name, the classic reason of the growth of the booming sector is, for example, the discovery of oil reserves or other specific factor endowments in a sector. We can generalize this shock as a technological shock, which shifts up the value of marginal product of labor of the sector and shifts the country's production possibility frontier outward in a biased fashion to the booming sector. Another common shock is a world price shock or ToT shock for a small country, which shifts up the value of marginal product of labor but does not shift the production possibility frontier of the economy.

Corden and Neary (1982) explores various possibility of such shocks by applying the classic specific-factor model as in Jones (1971) and Snape (1977). Their main question is the distribution of gains between factors. They also discuss whether such shocks result in deindustrialization to the economy. Their analysis emphasizes two channels by which how shocks to a tradable sector affect the distribution of gains to factor owners. The first channel is the "resource movement effect" in which the growing tradable sector absorbs mobile factor from other sectors. The other channel is the "spending effect" which represents endogenous changes in prices due to increases in income. In this framework, the gains or losses depend on the mobility of factors between sector and the rank of factor relative intensity among the sectors. They show that there are environments in which trade shocks are pro-industrialization rather than dampening the industrial sector as the lagging tradable sector.

Meanwhile, Matsuyama (1992) provides an overlapping-generations model with perfect fore-

[5]Corden and Neary (1982) defines the Dutch Disease as the coexistence within the traded goods sector of booming subsector and lagging subsector.

sight that can rationalize structural adjustment in the medium run. In this setup too, the key feature is specificity of some factors to each sectors. Matsuyama (1992) assumes that a worker maximizes lifetime utility by choosing a sector in which she works while knowing that she cannot exit the sector until she dies. Accordingly, the speed of sectoral adjustment due to an exogeneous price shock will depend on demographic change, and in the medium-run the economy may not operate in its optimal allocation up until the adjustment resumes. Yet, such allocation is efficient. In the case of the economy facing an exogenous trade shocks such as ToT shocks, some workers are stuck despite the incentive to move to the growing sector. However, the new generation who are born after the shock will choose accordingly and hence the impact of the shock on allocation materializes.

More recent studies on this topic is motivated by the global commodity boom in the 2000s. One such study analyze how emerging economies in Southeast Asia respond differently after the shock. In particular, Coxhead and Jayasuriya (2010) show that the middle-income countries like Malaysia and Thailand have been transforming by moving up to higher-skilled manufacture industries, while Indonesia seems to struggle in keeping up with its lower-skilled manufacture industries and instead has grown its commodity sector even more. They rationalize these stylized facts by applying the Ricardian trade model based on Deardorff (1983) to see sectoral adjustment due to the trade shock. Then, they proceed to apply the specific-factor model to analyze any distributional impact. Given their main goal in understanding structural adjustment, they focus more on showing the effect of a uniform reduction of production costs in China, as the fuel of the global commodity boom and proliferation of regional production network in Asia in the 2000s.

As shown by these studies, this literature is taking a stark assumption that labor is fully mobile across sectors (and potentially other dimensions such as regions) or when it is not mobile at all such as in Matsuyama (1992). The research in this prospectus takes a milder stand on labor mobility by allowing some mobility across regions which differ in the endowment of specific factors. Reiterating the caution proposed by Goldberg and Pavcnik (2007) in performing cross-country regression to understand trade shocks, the empirical case I propose here provides a theoretical framework of trade shocks under the environment of some labor mobility within a country with variation in its

regions.

2.3 Spatial Economics

Locational choice, both by firms and workers, is an endogeneous outcome. This fact is especially relevant in medium-run and long-run when people[6] and firms[7] can actually move to maximize utility or profit. These locational decisions then shape economic activities spatially, thus are important in understanding welfare changes. Theoretical papers such as Allen and Arkolakis (2014) and Redding (2016) show that in an open economy environment with factor movements, welfare changes are not only driven by changes in trade shares and trade elasticity, as concluded by Arkolakis et al. (2012), but also by changes in population shares. One stark implication of incorporating spatial economics is that we usually relax the strong assumption on local labor markets (or factor markets). We no longer take either of the two extreme, namely assuming labor is perfectly mobile across regions or assuming labor is perfectly immobile across regions.

Moreover, spatial economics take into account the role of amenities in locational choice or residential choice. There are two approaches to including amenities. First by treating it as an exogenous parameter that captures the fundamentals of a location, as in Redding (2016).[8] In his setup, regions can potentially be different as we allow workers to have heterogeneous preferences on amenities for each location. Meanwhile, any congestion will be captured by rent prices of land. Another approach is treating amenities as an endogeneous variable, that is driven by some exogeneous parameters but also endogeneous outcomes like congestion.[9] Such an approach is taken by a study on internal migration in Indonesia by Bryan and Morten (2017).

In the case of heteregenous productivity across agents, the literature includes locational decisions to affect the selection mechanism . If frictions in labor mobility are present, then these frictions can affect the productivity of each region. In addition, productivity can also depend

[6]In medium-run or long-run, worker can accummulate sufficient fixed cost to move or sufficient time in finding jobs in other location.

[7]In medium-run or long-run, firms can deplete its immobile factors such as capital. This dynamic has been shown to be empirically important to regional economic activities, as for example shown by Dix-Carneiro and Kovak (2017) on the dynamic impacts of trade liberalization in Brazil.

[8]Other literatures in this stream include Moretti (2011). See also Glaeser and Gottlieb (2009) for discussion.

[9]Some studies taking this approach include Allen and Arkolakis (2014) and Diamond (2016).

on agglomeration forces. Hence, in the presence of migration costs, we may see misallocation of resources due to the fact that the best worker cannot move to where she can be most productive. As estimated by Bryan and Morten (2017), this misallocation is modest but not negligible. They estimate a labor productivity gain of 22% by removing all barriers to migrate in Indonesia, while a gain of 8% by reducing barriers to US level.

Furthermore, costs of migration may provide an explanation of persistence wage gaps across regions in an economy even when it does not have particular legal or political barrier to move, such as the Hukou system in China for instance. Shenoy (2016) estimates that over the long term, migration costs contribute to 18-22% of spatial variation in earnings across provinces in Thailand. Reiterating the importance of amenities, he also estimates that roughly 80% of observed variation in earnings is due to amenities. In his empirical setting, he finds that the estimated perceived cost of migration is approximately 30%-110% of average earnings while 60% of these costs is a fixed cost.

Moreover, unlike most papers in spatial economics which concern on static gains from reducing barriers to move and hence use permanent migration as the variable of interest, this paper aims to contribute to the literature by focusing on recent migration. Throughout the paper, we define recent migration as change of residence between five years prior to a survey year. Understanding recent migration is important as it captures the dynamic of how a relative price shock, e.g. world price shocks, propagates and/or dissipates throughout the country.

2.4 Information Frictions in Trade

The seminal paper by Allen (2014) shows that even within one economy and with trade of homogenous goods, there may still be frictions in trade between regions of the economy. His paper focuses on information frictions in trade of agricultural commodities between regions in the Philippines. Motivated by this finding, there is possibility that such frictions may also drive labor mobility across regions in Indonesia, as we also see in-migration and out-migration between local labor markets, on top of the possible drivers in the form of selection and agglomeration.

3 Theoretical Framework

I combine the classsical specific factor model and a spatial economy framework by allowing for local labor market to face an upward sloping labor supply. The main difference with Redding (2016) is that we assume a small-open economy that engages in trade with no iceberg trade cost, both for international trade and interregion domestic trade. In addition, we simplify the model assuming a two-sector economy with each sector having a specific factor in its production function.

3.1 Environment

Consider a small open economy consists of N regions, indexed by $n \in N$. There are two sectors, indexed by $j = 1, 2$. The first sector is the non-commodity sector, labelled as sector 1. The second sector is the commodity sector, labelled as sector 2. Both sector uses labor as inputs and a specific factor. In this set-up, the non-commodity sector uses labor and capital, while the commodity sector uses labor and land. Total endowment of labor in the economy is fixed at the amount of $\bar{L}$. Meanwhile, goods produced by both sectors are homogeneous and are freely traded internationally and domestically in perfect competition markets. Let us denote the relative price of sector 2 relative to sector 1, p_2.

Consumer Preferences Preferences of each worker ω are defined over consumption on goods produced by the non-commodity sector and commodity sector, as well as amenities provided by the region where she chooses to live:

$$U_n(\omega) = b_n(\omega) \left(\frac{C_1}{\sigma}\right)^{\sigma} \left(\frac{C_2}{1-\sigma}\right)^{1-\sigma}, \tag{1}$$

with $0 < \sigma < 1$. As in Redding (2016), each worker ω take an independent and idiosyncratic draw of b_n for each region n from Fréchet distribution:

$$G_n(b) = e^{-B_n b^{-\epsilon}}, \tag{2}$$

where B_n, the scale parameter, determines the average amenities for region n while ϵ, the shape parameter, determines the dispersion of amenities across workers for each location. The higher ϵ, the less dispersed are amenities across regions. Each worker is endowed with a unit of labor which she supply inelastically.

Price Index Given preferences and the choice of the non-commodity sector 1 as the numeraire, the price index in region n is:

$$P_n = p_2^{1-\sigma}. \tag{3}$$

Note that price index is the same in all regions due to small-open economy assumption and lack of trade cost. Hence we can further define $P \equiv P_n$ for all $n \in N$.

Production and Technology The production functions of both sectors are Cobb-Douglas using labor and the specific factor of each sector. The production function of the non-commodity sector in region n is the following:

$$Y_{n1} = \left(\frac{L_{n1}}{\alpha}\right)^{\alpha} \left(\frac{K_n}{1-\alpha}\right)^{1-\alpha}. \tag{4}$$

Meanwhile, the production function of commodity sector in region n is:

$$Y_{n2} = \left(\frac{L_{n2}}{\beta}\right)^{\beta} \left(\frac{T_n}{1-\beta}\right)^{1-\beta}. \tag{5}$$

Hence, the zero-profit condition implies:

- for sector 1: $1 = w_n^{\alpha} r_{Kn}^{1-\alpha}$
- for sector 2: $p_2 = w_n^{\beta} r_{Tn}^{1-\beta}$

Meanwhile, labor demand for each sector in each region n is:

- for sector 1: $L_{n1}^D = \frac{\alpha Y_{n1}}{w_n}$
- for sector 2: $L_{n2}^D = \frac{\beta p_2 Y_{n2}}{w_n}$

Thus, total labor demand in region n is the sum of labor demand for each sector in the region, i.e:

$$L_n^D = \frac{\alpha Y_{n1} + \beta p_2 Y_{n2}}{w_n}. \tag{6}$$

Income Each worker receives wages for the labor services she provided by working in region n. Moreover, I assume that the rent for capital and land in the whole economy is distributed lump-sum to all the population. Hence, for a worker in region n, her income equals:

$$v_n = w_n + \varphi, \tag{7}$$

where

$$\varphi \equiv \frac{\sum_{n=1}^{N} r_{Kn} K_n}{\bar{L}} + \frac{\sum_{n=1}^{N} r_{Tn} T_n}{\bar{L}}.$$

Residential Choice Each worker maximizes her utility in (1) by taking into account her idiosyncratic preferences on amenities for each region. Using the properties of Fréchet distribution, the probability that a worker chooses to live in region $n \in N$ is:

$$\frac{L_n}{\bar{L}} = \frac{B_n \left(\frac{v_n}{P_n}\right)^{\epsilon}}{\sum_{k=1}^{N} B_k \left(\frac{v_k}{P_k}\right)^{\epsilon}}. \tag{8}$$

This system of equation represents labor supply in each region $n \in N$. This system allows upward-sloping labor supply, in which we can expect higher share of population will choose to live in regions with relatively higher income and amenity levels.

Equilibrium Equilibrium in the economy is defined as $\{w_n, L_n, L_{n2}, r_{Kn}, r_{Tn}\}$ for each region $n \in N$ that solves the following system of equation:

$$p = w_n^{\beta-\alpha} r_{Tn}^{1-\beta} r_{Kn}^{\alpha-1}, \tag{9}$$

$$L_n = L_{n1} + L_{n2} \tag{10}$$

$$\frac{L_n^D}{\bar{L}} \equiv \frac{\frac{\alpha\left(\frac{L_{n1}}{\alpha}\right)^{\alpha}\left(\frac{K_n}{1-\alpha}\right)^{1-\alpha}}{w_n} + \frac{p_2\beta\left(\frac{L_{n2}}{\beta}\right)^{\beta}\left(\frac{T_n}{1-\beta}\right)^{1-\beta}}{w_n}}{\overline{L}} = \frac{B_n\left(\frac{v_n}{P_n}\right)^{\epsilon}}{\sum_{k=1}^{N} B_k\left(\frac{v_k}{P_k}\right)^{\epsilon}} \equiv \frac{L_n^S}{\bar{L}}, \tag{11}$$

$$p_2 = \left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}\left(\frac{1-\beta}{\beta}\right)^{1-\beta}\frac{K_n^{1-\alpha}}{T_n^{1-\beta}}\frac{L_{n2}^{1-\beta}}{L_{n1}^{1-\alpha}}, \tag{12}$$

$$\sum_{n=1}^{N} L_n = \bar{L}. \tag{13}$$

3.2 Exogenous Price Shock

We would like to analyze the impact of an exogeneous price shock to wages in different regions. If labor had full labor mobility, wages across regions will equalize. Conversely, if regions as local labor market have fixed amounts of labor, i.e. no labor mobility across regions, then the exogeneous price shock would be localized and the impact in the short run would be as predicted in the classic specific-factor model. That is, the exogeneous increase in price would be followed by increase in wages of a lower percentage change.

Allowing for full labor mobility, but with heterogeneous preference across regions, will provide a framework between the two extreme case explained above. From the labor-supply side, each worker will consider all regions and maximize her expected utility. Meanwhile, since each region may differ in their endowments of specific-factors in each sector, the exposure to the shock will vary across regions despite all of them facing the same price shock. This variation in exposure to shocks leads to variation in labor demand responses in each region. Hence, we expect to see variation in wages response in different regions from a universal price shock.

In order to derive the intuition above, consider a simple case when labor intensity in sector 1 and sector 2 are assumed to be equal, i.e. $\alpha = \beta$. Suppose there is an exogenous change in the relative price of sector 2. In order to see the changes in labor demand in region n, totally differentiate (6) and use the Envelope Theorem to obtain:

$$\hat{L_n^D} = \gamma_{n2}\hat{p_2} - \hat{w}, \tag{14}$$

where $\hat{x} \equiv {}^{dx}/_{x}$ and $\gamma_{n2} \equiv \frac{\alpha p_2 Y_{n2}}{\alpha(Y_{n1}+p_2 Y_{n2})}$, which is the share of sector 2 in the total output of region n.

Meanwhile, we totally differentiate (8) to see the changes in labor supply in region n:

$$\hat{L_n^S}\frac{L_n^S}{\overline{L}} = \epsilon B_n (w_n + \varphi)^{\epsilon-1} w_n \hat{w_n} - \left[\sum_{k=1}^{N} \frac{w_k \hat{w_k}}{\epsilon B_k (w_k + \varphi)^{\epsilon-1}}\right]. \tag{15}$$

Let us define $\hat{D} \equiv \sum_{k=1}^{N} \frac{w_k \hat{w_k}}{\epsilon B_k (w_k+\varphi)^{\epsilon-1}}$. Hence,

$$\hat{L_n^S}\frac{L_n^S}{\overline{L}} = \epsilon B_n (w_n + \varphi)^{\epsilon-1} w_n \hat{w_n} - \hat{D}. \tag{16}$$

Armed with the change in labor demand in (14) and the change in labor supply in (16), we can use the population-mobility condition in (13) to solve fo the changes in wages due to changes in price. From (13) we have:

$$\sum_{n=1}^{N} \hat{L_n^S}\frac{L_n^S}{\overline{L}} = 0. \tag{17}$$

Using (16), we can get:

$$\sum_{n=1}^{N} \left[\theta_n \hat{w_n} - \hat{D}\right] \frac{L_n^S}{\overline{L}} = 0 \tag{18}$$

$$\Leftrightarrow \hat{D} = \sum_{n=1}^{N} \theta_n \frac{L_n^S}{\overline{L}} \hat{w_n} \tag{19}$$

where we define $\theta_n \equiv \epsilon B_n (w_n + \varphi)^{\epsilon-1} w_n$.

Furthermore, using the labor-market clearing condition in each region $n \in N$ as in (12),

$$\hat{L_n^D} = \hat{L_n^S} \tag{20}$$

$$\Leftrightarrow \gamma_{n2}\hat{p} - \hat{w_n} = \theta_n \hat{w_n} \frac{\overline{L}}{L_n^S} - \hat{D}\frac{\overline{L}}{L_n^S} \tag{21}$$

$$\Leftrightarrow \hat{w_n} = \left(\frac{\lambda_n}{\lambda_n + \theta_n}\right)\left[\gamma_{n2}\hat{p} + \frac{\hat{D}}{\lambda_n}\right] \tag{22}$$

where we define $\lambda_n \equiv \frac{L_n}{\overline{L}}$.

Proposition 1. *For a given change in relative price,* $\hat{p}$*:* $\frac{\lambda_n}{\lambda_n+\theta_n}\gamma_{n2} > \frac{\lambda_m}{\lambda_m+\theta_m}\gamma_{m2} \Rightarrow \hat{w_n} > \hat{w_m}$*, where* $\lambda_n \equiv \frac{L_n}{\overline{L}}$*,* $\theta_n \equiv \epsilon B_n(w_n + \varphi)^{\epsilon-1}w_n$*,* $\gamma_{n2} \equiv \frac{\alpha p_2 Y_{n2}}{\alpha(Y_{n1}+p_2 Y_{n2})}$*.*

Facing a uniform price shocks, the impacts on wages across regions differ. The changes in wages at region n depends on the region's share of population, amenity level, and sectoral composition. Intuitively, an increase in relative price of sector 2 increases the demand for labor in sector 2. This mechanism allows a uniform price shock to expose regions differently. Meanwhile, the increase in demand for labor in sector 2 in region n pushes up the wage in region n, which attracts workers to move to region n. The movement of workers now affects changes in wages as more workers move to the region, the higher supply of labor faced by the region. This is when the upward-supply of labor kicks in. The magnitude of changes in wages then depends also on labor share and amenity level as these two factors affect labor supply. A region with relatively higher amenity level attracts more workers. Thus, for a given price shocks and sectoral composition, the higher the amenity level of a region is, the less the impact of price shocks on changes in the region's wage.

4 Empirical Exercise

Armed with the prediction of the theoretical model, this research tries to apply it to the case of the global commodity boom era in the 2000s as an exogenous price shock to Indonesia, modeled as a multi-region small open economy. There are various studies showing that the massive increase in commodity prices in that decade were not driven by increases in productivity or technological progress in commodity producers. Rather, this boom was fueled by factors that are potentially external to most commodity producers. Haniotis and Baffes (2010) show that these factors include low past investment in extractive commodities, the weak dollar, fiscal expansion in developed economies, and lax monetary policy in many countries. Coxhead and Jayasuriya (2010) state that the boom was driven by the growth of China.

Figure 8 in Appendix C shows the movement of some price indices for the main commodity bundles. It shows that between 2004 to 2014, with some correction during the Global Financial Crisis of 2008-2009, there was a widespread increase in commodity prices. Looking at the series for Indonesia's top three main commodities in Figure 9 and Figure 10 in Appendix C, i.e. palm oil, rubber and coal, the same trend persists. The prices of these commodities show significant increase, even after deflated by Indonesian CPI and rupiah appreciation.

Indonesia is an ideal case to be modeled as a multiregion small-open economy with some labor mobility. There are no restrictions in moving to other regions in Indonesia. Despite great cultural differences including in local languages, people use the country's official language widely across the country. Nevertheless, labor mobility is not highly fluid relative to the US, for example, as there are still some migration costs which include psychological cost of not living nearby family.[10] In this prospectus, we use recent migration as migration flow, defined as a change of residential location across districts between survey years and five years prior to the survey years.[11] This type of migration is particularly relevant to study the impact of price shocks on labor mobility. Figure 11 in Appendix E shows the variation of share of inward migration relative to destination population across districts in Indonesia. The median district has inward migration of 3.26% of its population. Moving from the 10th percentile to 90th percentile equals to an increase of inward migration share from 0.95% to 7.52%. Table 10 in Appendix E shows the summary statistics for share of net-inward migration in recent survey years.

4.1 Data

Throughout the research, I use thes district level as unit of observation for a region. The district is the second-level administrative unit in Indonesia. It is the lowest structure for government autonomy, in which district governments have independence in budget allocation. Moreover, the head of district as well as parlementary membership at the district level are elected directly by residents of the districts. The district level is also the relevant unit of labor market as minimum

[10]Bryan and Morten (2017) estimate that the average iceberg migration cost in the US is 0.22 while it is 0.56 in Indonesia.

[11]In contrast, Bryan and Morten (2017) focus more on permanent migration, defined as a change of residence relative to birth location, as they focus more on static (long-run) gains.

wage determination is set at the district level.[12]

Hence, in most of empirical exercise I focus on datasets that are representative up to the district level.

National Socio-Economic Survey (SUSENAS) This household survey provides the most comprehensive household's expenditure pattern and other social and economic indicators annually for Indonesian economy. The database is sampled from around 300,000 households and is representative up to the district level. SUSENAS is the main dataset to compute poverty rate and inequality measures. Given its strength in capturing household expenditure, these poverty rates and inequality measures are consumption-based measures. This research will use household expenditure data per district as a proxy of income[13] as well. Since 2011, SUSENAS includes questions on migration behaviour that were previously can only be captured every 5 years using census and between-census population survey.

INDO-DAPOER This dataset presents various economic indicators disaggregated to the province and district level. The dataset is summarized from different official datasets and compiled by the World Bank. INDO-DAPOER provides sectoral regional GDP at the district level annually since 2000. The disaggregation of these sectors is presented in Appendix G. We use agriculture and mining sector's contribution to regional GDP as the weight of commodity sector for each district in the model. We also use estimates of labor force, number of employment, and total population by district from this dataset.

Village Census (PODES) This is a triannual census covering information of social, economic and geographic condition of all villages in Indonesia. It includes questions on demography, natural resources, quality and quantity of infrastructure, and various economic variables. I use this dataset

[12]Except for the capital city of Jakarta which is granted autonomy up until province level only hence budget allocation and minimum wage setting are set in the province level.

[13]Deaton (1997) discusses the advantages in using expenditure to capture lifetime well-being. As summarized by Goldberg and Pavcnik (2007), these advantages include (1) conditional on agents can shift intertemporal resources, current expenditure better captures lifetime well-being, (2) there is less problem in reporting for consumption data than income data, (3) changes in relative prices affect consumers not only through income but also purchasing power of their current income.

to get indicators on observed amenities.

IMF Commodity Price Series and IFS Exchange Rate Data In order to get world price change, I use IMF Commodity Price series. Most price series are in US dollars. Hence I correct the price change with rupiah-USD exchange rate changes over the same period, taken from IFS data.

4.2 Empirical Results

The following subsection covers some results of empirical exercises with some discussion on their outcomes. I start with a discussion on the evidence for potential upward supply of labor faced by each district. This result motivates the theoretical framework that generalizes the supply of labor for each region. I continue with a discussion on the measurement of price shock. I show how a uniform price shock can vary greatly across districts due to the sectoral composition of each districts. Thus, the uniform price shock exposes each district in different magnitudes. Then, I discuss the estimated amenities obtained from labor supply estimation. Lastly, I test Proposition 1 empirically using the computed price shock and a measure of wages.

Labor Supply Estimation

In the theoretical framework, we derived the system of labor supply equations as shown in (8). Normalizing this equation with a base region, one arrives to:

$$\frac{L_n}{L_1} = \frac{B_n \left(w_n + \varphi\right)^{\epsilon}}{B_1 \left(w_1 + \varphi\right)^{\epsilon}}. \tag{23}$$

Then, taking its logs:

$$\log l_n = \log b_n + \epsilon \log \left(\frac{w_n + \varphi}{w_1 + \varphi} \right), \tag{24}$$

where we define $l_n \equiv \frac{L_n}{L_1}$ and $b_n \equiv \frac{B_n}{B_1}$.

Hence, our empirical strategy to test for an upward-sloping labor supply curve faced by each

region is the following:

$$\log l_{nt} = \delta_n + \epsilon \log w_{nt} + \varepsilon_{nt}, \tag{25}$$

where l_{nt} is relative population for district $n$at year t, δ_n is district fixed effect which captures relative amenities, w_{nt} is relative income (or proxy for income) per capita for district n at year t, and ε_{nt} is stochastic error.

Using expenditure per capita data and labor force data compiled in INDO-DAPOER[14], we get the results shown in Table 3.[15] These results show that the estimated dispersion parameter is positive. This potentially supports the assumption that regions on average face upward labor supply function.[16] As a comparison, Bryan and Morten (2017), with a slight different set up, estimate it to be 3.[17]

Table 3: Labor Supply Estimation

	I	II	III
relative expenditure per capita	0.0583***	0.0583***	0.0583***
	(0.00975)	(0.00975)	(0.0125)
Constant	-1.785***	-3.218***	-3.218***
	(0.00402)	(0.0272)	(0.00792)
Observations	1971	1971	1971

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Unit of observation is district. This regression us a panel of districts over the year 2011, 2012, 2013, and 2014. Model I uses fixed-effect panel estimation. Model II uses random-effect panel estimation with district-FEs. Model III uses clustered standard error in province level with district FEs.

[14]The sources of these data in INDO-DAPOER are SUSENAS and National Survey of Labor Force.

[15]The results using total population and number of employed workers are presented in Table 8 and 9 in Appendix D.

[16]On Table 11 in Appendix E, I show that the correlation between share of inward migration and expenditure per capita in destination is positive and statistically significant in order to further support the assumption on allowing upward labor supply faced by regions. A simple exercise to see elasticity of migration flows also confirms this, as show on Table 12 in Appendix E.

[17]Bryan and Morten (2017) assume heterogeneity in skills of workers instead of preference on amenities. They also use Fréchet distribution for the skill distribution, which allows them to estimate parameters using gravity equation. Their framework results to a gravity of migration flow between regions with wages at the destination, instead of population shares and relative wages.

Measurement of the Price Shocks

There are two types of shocks. The first one represents price shocks in agricultural commodities, while the second one represents price shocks in mining commodities. The price change of a commodity is computed as the percentage change between the price of the commodity in January 2004 and its price in December 2010, deflated by the Indonesian CPI and rupiah appreciation.

Given the very broad sectoral disaggregation in regional GDP as shown in Figure 13 in Appendix G, I use several different commodities to represent the agriculture sector and the mining sector. Table 4 below shows the selected commodities for which their international prices are taken as representatives of the sectors' bundle..

Table 4: Selected Commodities for Each Sector Bundles

Sector Bundle	Selected Commodities
Food crop	rice
Plantation crop	coffee, palm oil, cocoa, rubber
Farming	beef
Forestry	hard log
Fisheries	shrimp
Oil and gas	fuel index
Other mining	fuel index and metal index
Quarrying	metal index

I use national GDP by sectors as weights to create an Indonesian specific price shock in agriculture commodities and mining commodities. These changes in prices are uniform across all districts.[18] Variation in exposure to shocks stems from the share of the agriculture sector and mining and quarrying sector in each district's regional GDP obtained from INDO-DAPOER dataset. Figure 3 and Figure 4 below show the variation in exposure to price shocks in agriculture sector and mining sector across districts. Summary statistics for both types of price shocks are presented in Table 6 in Appendix A.

[18]Details on weights and price changes are shown in Table 7 in Appendix C.

Figure 3: Calculated Price Shocks in Agriculture Sector

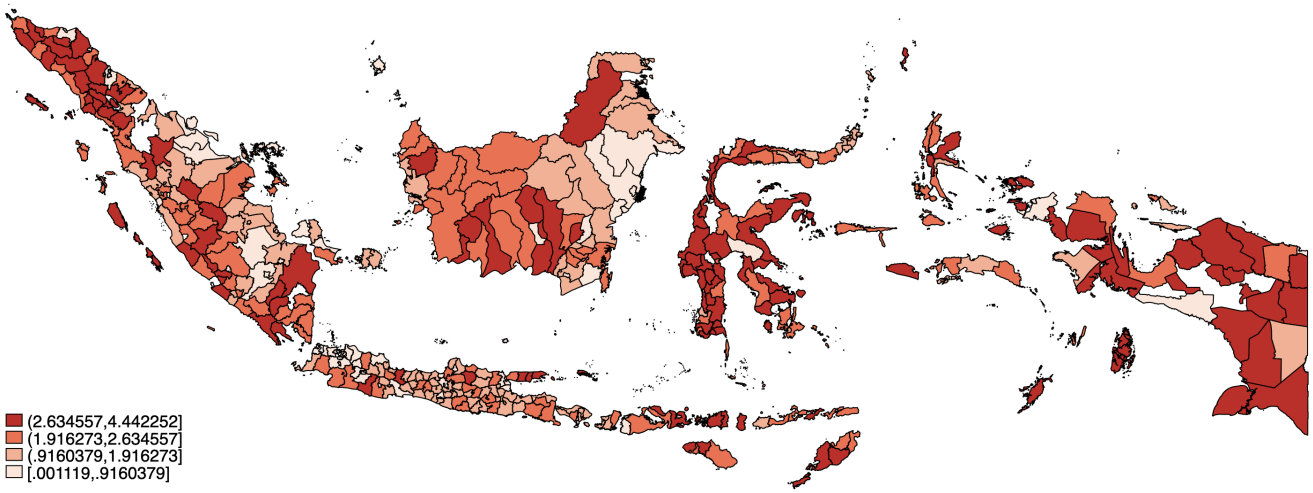
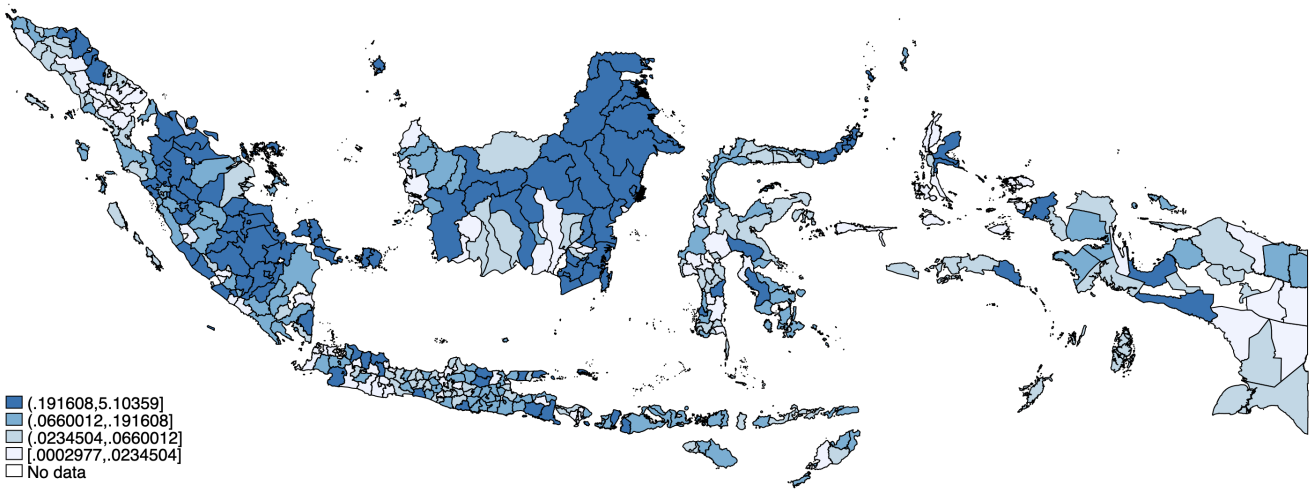


Figure 4: Calculated Price Shocks in Mining Sector



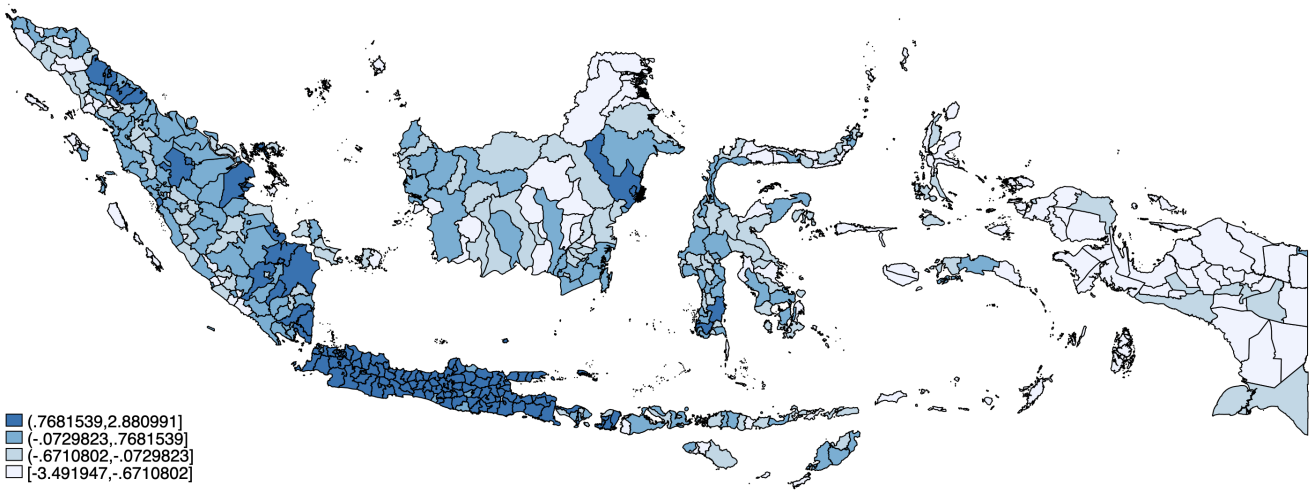
There are some weaknesses stemmed in using the broadly disaggregated regional GDP as the weights to measure exposure to shock. First, food crops take a big portion in the weight for agriculture price index (50.3%) as it is driven mainly by rice which has relatively high increase in price during the global commodity boom. This increase in the price of food crop, since it is mainly consumed, deteriorates the Terms of Trade instead of leading to an improvement of real income. Second, plantation crops take a relatively small portion of weight for agriculture commodity bundle (15.8%). As Indonesia is a net exporter in this type of crop, an increase in the price of plantation crops improves the Terms of Trade. Yet since we use national weight, it is translated to a relatively small magnitude despite these crops are main income for several regions. I will discuss plans to

overcome this problem in the last section of this prospectus.

Estimated Amenities Across District

The labor supply estimation using equation (25) also allows one to estimate relative amenities predicted by the model. Estimated relative amenities are represented by the district fixed effects. The variation of these estimated relative amenities is presented in Figure 5. In general, the estimated amenities confirms the tendency for higher amenities in districts in Java island where infrastructure and other public services are more accessible and in relatively better condition. Moreover, simple correlation analysis as presented in Table 13 in Appendix F shows that higher relative estimated amenities positively correlate with lower vulnerability to natural disasters, better access to health clinics and lower distance to commercial complex as well as more permanent markets and banks.[19]

Figure 5: Estimated Relative Amenities



Empirical Test of Proposition 1

Next, I try to test the prediction of Proposition 1. Particularly in this subsection, I estimate the correlation between changes in income with shocks. As explained above, shocks vary across districts due to the variation in sectoral contributions of agriculture and mining. These two sectors

[19]The results show that regions with higher relative estimated amenities are associated with less number of hospitals. This may reflect the condition that most hospitals are concentrated in cities with high agglomeration force due to close connection with medical schools.

represents γ_{n2} for each district n as in the theoretical framework.

I use log changes in average expenditure per capita in each district between 2005 and 2011 to match the period of the price shocks. More specifically, I estimate the following regression:

$$\log \hat{w}_n = \alpha + \beta_{ag} \left(\log \hat{p}_{ag} . \gamma_{ag,n} \right) + \beta_{min} \left(\log \hat{p}_{min} . \gamma_{min,n} \right) + \nu_n \tag{26}$$

where $\hat{w}_n$ is proportional change of average expenditure per capita in district n between 2005 and 2011, $\hat{p}_{ag}$ and $\hat{p}_{min}$ are proportional change in price of agriculture commodities bundle and mining commodities bundle as between January 2004 and Dec 2010, $\gamma_{ag,n}$ and $\gamma_{min,n}$ are share of agriculture sector and mining and quarrying sector for each district n in 2004, and ν_n is stochastic error.

The results are presented in Table 5. The empirical exercise seems to confirm the prediction of the model. We find positive and statistically significant correlations between the measures of price shocks in agriculture commodities and mining commodities with changes in expenditure per capita.

Table 5: Test on Proposition 1

	Changes in Expenditure/Capita	Changes in Expenditure/Capita
Price Shocks in Agriculture Sector	0.116***	0.102***
	(0.0131)	(0.0137)
Price Shocks in Mining Sector	0.0813***	0.0682***
	(0.0159)	(0.0154)
Population Share		0.506
		(0.338)
Estimated Amenities		-0.579
		(0.338)
Constant	0.128***	5.323
	(0.0290)	(3.436)
Observations	382	382

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

These positive and statistically correlations between the measure of price shocks in agriculture and mining commodities are also preserved when I include population share and estimated amenities. Population shares has positive correlation yet is not statistically significant. Meanwhile, as predicted by the theoretical framework, we find negative correlation, although only statistically significant in 90% confidence interval, between estimated amenities and changes in expenditure per capita. This implies that workers are willing to get lower earnings if they can get better amenities.

5 Plans Ahead

The development for the this paper includes two main plans for action. The first one is to make a significant correction in the construction of the price shocks. The second one is to perform rigorous empirical exercises in showing causality between price shocks and labor mobility across regions and ultimately how they matter to regional wages.

As explained in the previous section, there are some weaknesses of the current measures which stemmed in using the broadly disaggregated regional GDP as the weights to measure exposure to shocks. In order to overcome these challenges, I plan to obtain Indonesia's Agriculture Census data. It is a census of agriculture households and firms, done every 10 years. The last two were delivered in 2003 and 2013. Since it captures the universe of farmers and plantations, we can construct a much more detailed composition of agriculture sector by each district. The dataset provides data on the hectares of land for each commodity and the amount planted of each crop owned by agriculture households and firms. Yet, the drawback is that there is no adjustment on the difference in crop yields or productivity. However, there are studies that use rainfall data to adjust for productivity. This approach is also possible to be followed for this research. The construction of the weights for mining price shock also suffers the same problem as those of agriculture price shock. My plan is to obtain data on mining companies from the Economic Census to better capture mining sector contribution by each district.

In regards to working on rigorous empirical exercises, I expect several challenges that I have to solve. First, identification strategy for migration. Since wages and migration choices are endoge-

nous outcome, I should study whether the price shocks can be an instrument for the impact of migration flows on regional wages. In addition, as seen in Table 10 in Appendix E, netmigration for each district can be small, but there are sizable flows inward and outward each district. Echoing the study by Artuç et al. (2010), only focusing on net-inflow may overlook the the importance of migration flows.

The second challenge is to study whether the use of expenditure per capita as a proxy of income is an appropriate measure for total income per capita. I will do robustness check by using wages data as well.

Lastly, the direction of the empirical exercise should be able to provide some empirical evidences on whether there is any difference in allowing for some mobility, full mobility, and perfect immobility to understand the changes in interregional inequality. This work also implies answering the question on whether the commodity boom was responsible for a faster convergence in 2005-2011 period compared to the more recent ones as shown in Table 2 in Appendix B. In overcoming this challenge, my plan is to extract district-premium welfare by running Mincerian regression on household's characteristics such as age and education of members of households, main source of income, etc. Then, analyze the changes in this district-premium welfare as driven by labor mobility and the price shocks.

Understanding whether this inequality is trade driven, or technology driven, or driven by other factors can better inform policymakers in addresing inequality. Such lessons can be relevant to all economies with rich geographical and socio-economic groups.

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A Summary Statistics

Table 6: Summary Statistics

Variable	Mean	Median	s.d.	10th Perc.	90th Perc.
Changes in Expenditure per Capita (2005-2011)	1.45	1.40	0.40	1.07	1.91
Price Shocks in Agriculture Sector	1.81	1.92	1.07	0.22	3.16
Price Shocks in Mining Sector	0.34	0.06	0.84	0.004	0.8

Notes: Expenditure per Capita is district average expenditure per capita.

B Convergence and Disparity

Figure 6: Real Expenditure per Capita in 2005 and 2011

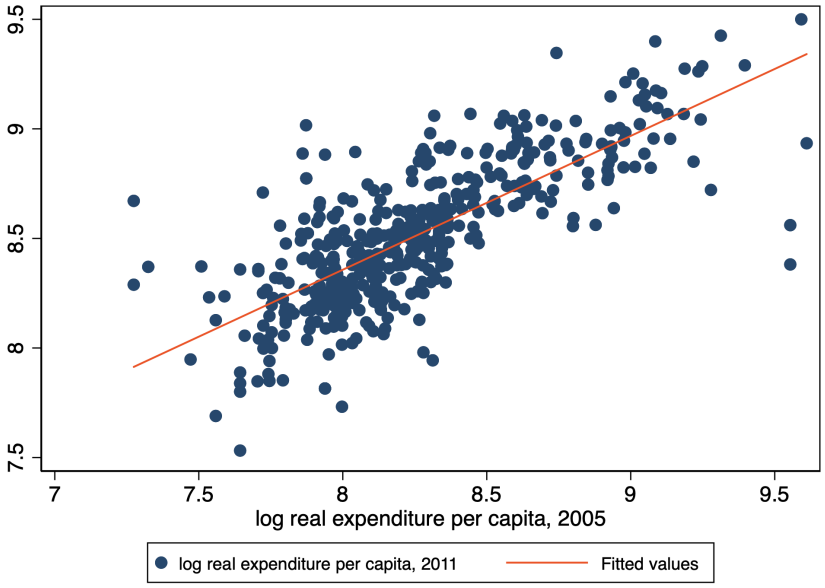
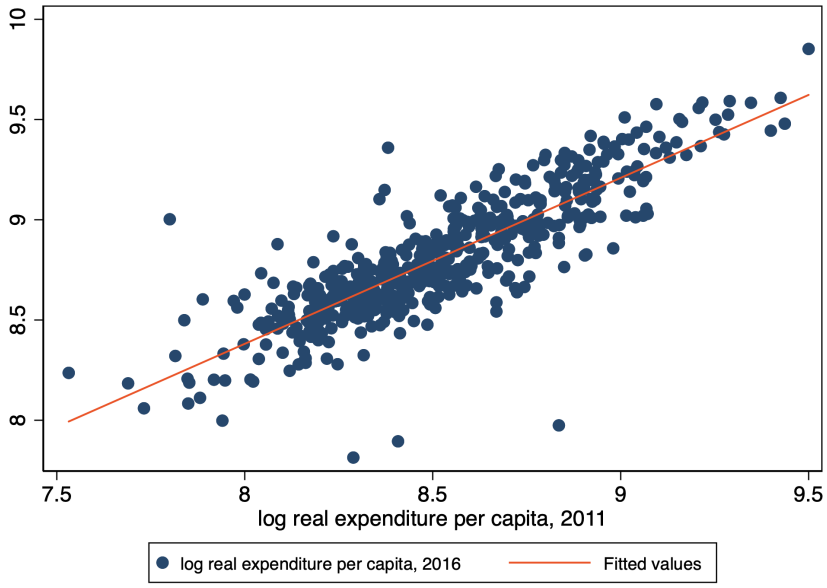
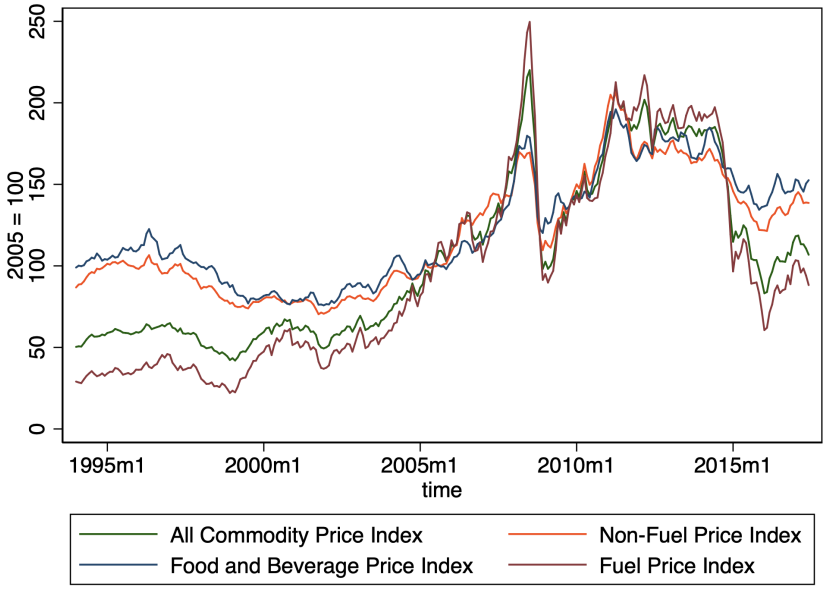


Figure 7: Real Expenditure per Capita in 2011 and 2016



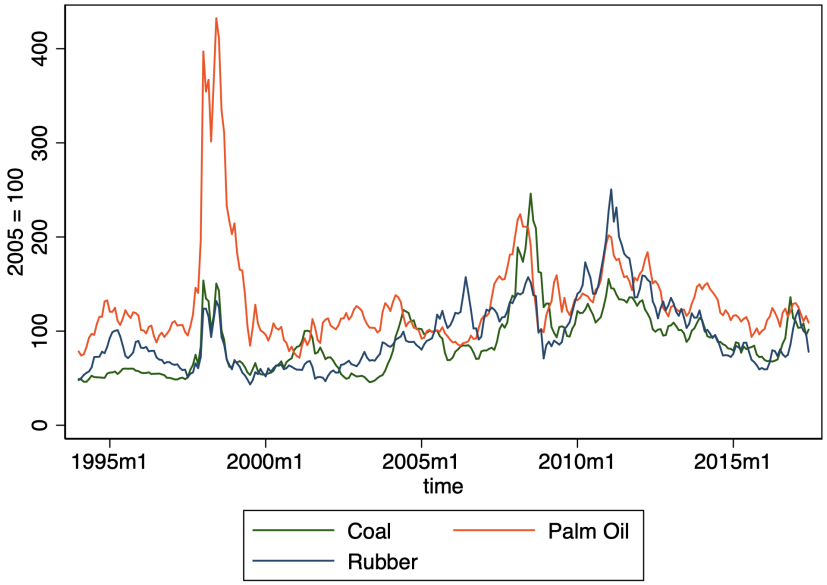
C Trend of Commodity Prices

Figure 8: Trend of Main Commodity Price Indices



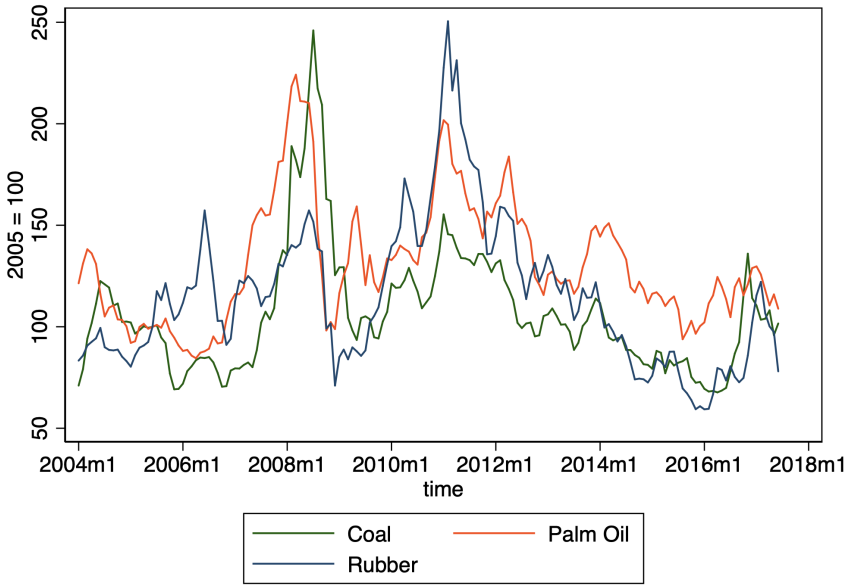
Source: IMF Commodity Price Series.

Figure 9: Trend of Prices of Indonesia's Main Commodity Export (1994 - 2017)



Source: calculated, prices are obtained from IMF Commodity Price Series, Indonesian CPI from Indonesia Central Statistic Agency, while rupiah to USD exchange rate from IFS.
Note: All prices are deflated to Indonesian CPI and rupiah's appreciation against USD.

Figure 10: Trend of Prices of Indonesia's Main Commodity Export (2004 - 2017)



Source: calculated, prices are obtained from IMF Commodity Price Series, Indonesian CPI from Indonesia Central Statistic Agency, while rupiah to USD exchange rate from IFS.
Note: All prices are deflated to Indonesian CPI and rupiah's appreciation against USD.

Table 7: Price Shocks Calculation

Sector Bundle	**weight**	**log price change**
Food crop	0.50	5.53
Plantation crop	0.15	5.63
Farming	0.12	5.04
Forestry	0.06	4.99
Fisheries	0.16	4.68
Agriculture		**5.31**
Oil and gas	0.58	5.29
Other mining	0.32	5.29 and 5.52
Quarrying	0.10	5.52
Mining		**5.35**

Notes: All log price changes are international price changes deflated by Indonesia's inflation and rupiah's appreciation.

D Labor Supply Estimation

Table 8: Labor Supply Estimation using Total Population Share

	I	II	III
relative expenditure per capita	0.00397*	0.00397*	0.00397
	(0.00179)	(0.00179)	(0.00494)
Constant	-1.720***	-2.947***	-2.947***
	(0.000724)	(0.00529)	(0.00280)
Observations	1491	1491	1491

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Model I uses fixed-effect panel estimation. Model II uses random-effect panel estimation with district-FEs. Model III uses clustered standard error in province level with district FEs.

Table 9: Labor Supply Estimation using Employment Share

	Model I	Model II	Model III
relative expenditure per capita	0.0478***	0.0478***	0.0478***
	(0.0105)	(0.0105)	(0.0114)
Constant	-1.775***	-3.226***	-3.226***
	(0.00434)	(0.0293)	(0.00722)
Observations	1971	1971	1971

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Model I uses fixed-effect panel estimation. Model II uses random-effect panel estimation with district-FEs. Model III uses clustered standard error in province level with district FEs.

E Domestic Migration in Indonesia

In this prospectus, migration is recent migration, defined as a change of residence compared to five years before survey years. Share of net migration is net inward migration relative to the population in destination district.

Figure 11: Share of Inward Migration to Destination Population, 2011

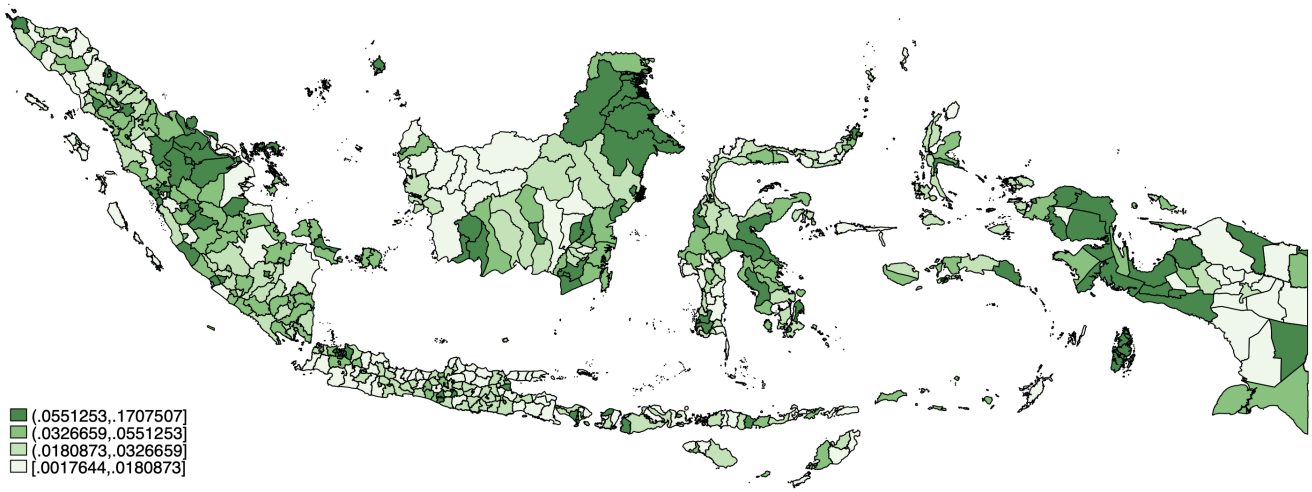


Table 10: Summary Statistics of Net Recent Migration

			2011		
	mean	p50	sd	p10	p90
share of net-migration	.3370568	.1022251	3.226049	-2.735379	3.991469
Observations	495				

			2012		
	mean	p50	sd	p10	p90
share of net-migration	.1954231	-.0004727	3.436446	-2.556991	3.528234
Observations	493				

			2013		
	mean	p50	sd	p10	p90
share of net-migration	-.0960649	-.2299668	3.065224	-2.407567	3.0388
Observations	494				

			2014		
	mean	p50	sd	p10	p90
share of net-migration	.569045	-.1406121	7.397227	-2.544859	3.380972
Observations	489				

			2016		
	mean	p50	sd	p10	p90
share of net-migration	9.244822	9.163298	3.52445	5.95061	13.03682
Observations	509				

Figure 12: Distribution of Share of Net Migration to Population in Destination District

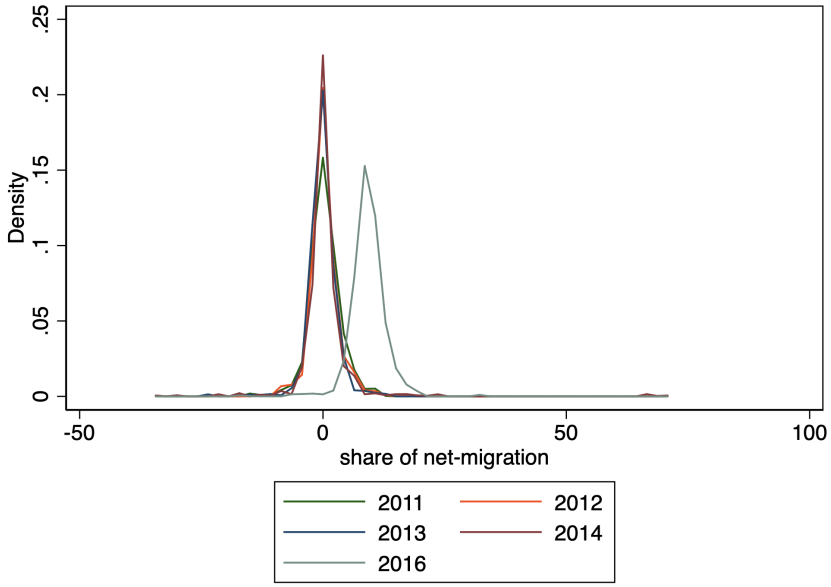


Table 11: Correlation between Share of Inward Migration and Expenditure per Capita in Destination District

	share of inward migration
wage in destination	1.464***
	(0.0714)
year=2011	0
	(.)
year=2014	-0.564***
	(0.0348)
year=2016	-0.876***
	(0.0495)
Constant	-22.83***
	(0.942)
Observations	1490

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Migration Elasticity

	Model I	Model II	Model III
Wage in Destination	0.488***	0.314***	0.488***
	(0.0213)	(0.0810)	(0.0226)
Wage in Origin	0.0684***	-0.0386	0.0684**
	(0.0199)	(0.0875)	(0.0210)
year=2011	0	0	0
	(.)	(.)	(.)
year=2014	-0.177***	-0.153***	-0.177***
	(0.0145)	(0.0344)	(0.0146)
year=2016	-0.270***	-0.160*	-0.270***
	(0.0202)	(0.0663)	(0.0211)
Constant	-1.739***	2.146	-1.739***
	(0.385)	(1.538)	(0.415)
Observations	33808	33808	33808

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Dependent variable is migration flows between districts. We set the data as a panel of partners over year. Model I uses random effects estimation. Model II uses fixed effects estimation. Model III uses robust estimator of variance.

F Observed and Estimated Amenities

Table 13: Correlation Analysis of Observed Amenities and Estimated Aminities

	estimated relative amenities
worship places	0.488***
	(0.0456)
no water pollution	-0.00335
	(0.0490)
no soil pollution	0.0967*
	(0.0429)
no air pollution	-0.0215
	(0.0432)
no noise pollution	-0.0790
	(0.0428)
less risk of natural disasters	0.140***
	(0.0354)
distance to junior high school	0.111
	(0.107)
distance to senior high school	-0.00867
	(0.132)
number of hospitals	-0.230***
	(0.0498)
difficulty in reaching health clinic	-0.151*
	(0.0720)
time to reach nearest district capital	-0.0167
	(0.0585)
distance to nearest post office	-0.157
	(0.104)
lack of mobile phone signal	0.0916
	(0.0767)
distance to nearest commercial complex	-0.230**
	(0.0876)
number of permanent markets	0.157***
	(0.0462)
number of banks	0.135*
	(0.0532)
Constant	0.147***
	(0.0336)
Observations	417
R^2	0.525

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Notes: Unit of observation is district. Indicators of observed amenities are obtained from Village Census (PODES) 2005. I collapsed each indicator to get district averages, weighted by population. All indicators are standardized to have a mean of zero and unitary standard deviation.

G Sectoral Disaggregation in Regional GDP

Figure 13: Sectoral Disaggregation of Regional GDP in District Level and National Level