Robot-Proofing Economic Development: Econometric, Growth Diagnostic, and Machine Learning Evidence

by

Eric Protzer

B.A. Economics, B.A.Sc. Mechanical Engineering
The University of British Columbia, 2017

Submitted to the
INSTITUTE FOR DATA, SYSTEMS, AND SOCIETY

in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE IN TECHNOLOGY AND POLICY

at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2019

Author ..... Signature redacted

Institute for Data, Systems, and Society

May 10, 2019

Certified by ..... Signature redacted

Elisabeth Reynolds

Executive Director, MIT Industrial Performance Center

Thesis Supervisor

Accepted by ..... Signature redacted

Noelle Selin

Director, Technology and Policy Program

Associate Professor, Institute for Data, Systems, and Society and

Department of Earth, Atmospheric and Planetary Sciences

THIS PAGE LEFT INTENTIONALLY BLANK

Abstract

Over the course of the 20th century numerous economies have leveraged export-driven industrialization strategies to grow wealthier. The advent of automation technology, however, threatens to disrupt the low-cost manufacturing models which have characterized this process; the future may see factories resituated to high-income, high-skill countries which can successfully deploy automation. This thesis consequently evaluates how developing countries could navigate automation by either innovating abreast of it or specializing away from its impact. It is broadly divided into three sections. First, the stage is set by examining the political economy of industrial policy to highlight how political incentives constrain feasible strategies for economic readjustment of any sort. It is shown that even in a setting with few corruption problems – the European Union – industrial policy is guided by politicians' incentives to maintain power, and thus one ought to be cognizant of such incentives in any context. Second, possible barriers to greater productivity and innovation in developing countries are explored through a case study analysis of Vietnam, which is considered by some to be highly exposed to automation risk. Growth diagnostic tools are applied to identify the binding constraints which prevent it from shifting towards more complex, value-added economic activities. Structural economic reform is found to be critical to greater innovation, as opposed to technocentric solutions that aim to leapfrog to the technological frontier. Third, product space and machine learning methodology are used to simulate how countries' export diversification paths could respond to automation. By conducting sensitivity analysis across a range of automation scenarios it provides insight on how developing countries may be able to respecialize their economies to maintain growth.

Special thanks to Dr. Jeffry Frieden, Dr. Ricardo Hausmann, and Dr. Stefanie Jegelka, whose classes incubated sections of this thesis; and to Divya Prabhakar and Linyan Xue, with whom I collaborated on a group project conducting a growth diagnostic analysis of Vietnam. With their permission I have included elements of that project for which I am the sole author in this thesis.

"Plans are useless, but planning is indispensable."

Dwight Eisenhower

Table of Contents

Chapter I – Introduction: The Disruption of Export-Led Growth

Nearly all major development success stories of the last century have employed export-driven growth strategies. Once-poor countries like Japan, South Korea, Taiwan, and Singapore leveraged their comparative advantages in inexpensive labor to export increasingly sophisticated products, typically upgrading from textiles to electronics, machinery, chemicals, automobiles, and beyond. A number of developing countries such as China, Vietnam, Thailand, Malaysia, and Indonesia are partway through similar processes. Given the paucity of alternative growth pathways there is consequently very serious concern among developing-world policymakers that nascent automation technologies could reshore their exports to the developed world – that is, repetitive, low-skill manufacturing jobs which have historically driven growth may be supplanted by machines in wealthy, high-skill countries. Following a 2016 International Labor Organization (ILO) report that 70% of Vietnamese jobs are at high risk of automation in the coming decades, for example, the Cabinet of Vietnam has sought advice the world over on how it can navigate technological disruption.

Some of this risk is probably overhyped. Most sky-high estimates of automation risk, such as that aforestated for Vietnam, are based on the seminal and controversial Frey and Osborne (2013), which concludes that 47% of US jobs are at high risk of automation. Their methodology is to ask experts about the automation risk of a handful of jobs, then apply machine learning to data on the task composition of 702 American jobs to predict automation scores widely. A variety of criticisms have been levied against this methodology; Nedelkoska (2018), for instance, uses the same survey data but takes into account differences in task composition within the same occupation, concluding that only 14% of jobs in the OECD are at high risk of automation.

Nevertheless even lowball estimates, like 9% of OECD jobs according to Arntz, Zierhan, and Gregory (2016), foretell the possibility of substantial disruption in absolute terms. It is thus vitally necessary for policymakers to consider how to respond to automation. In the developing world, a critical aspect – arguably the overriding concern – is preparing for the possibility of reshoring. A laissez-faire approach seems obviously inadequate; export niches will simply slip away. The question facing policymakers, which constitutes the research question of this thesis, thus becomes *what policy interventions can developing countries use to navigate the threat of export reshoring due to automation technologies?*

Most literature on the economic impact of automation has focused on the developed world, and has generally examined labor market effects. As aforesaid, several important studies create sharply

disagreeing projections of the proportion of jobs at a high risk of automation in the US and OECD, namely Frey and Osborne (2013), Arntz et al. (2016), and Nedelkoska (2018). Acemoglu and Retrepo (2017) show that the increased prevalence of robots in certain manufacturing industries has already led to decreasing employment and wages in the US. Acemoglu and Restrepo (2018) develop a theoretical framework to decompose the labor market effects of automation in terms of task content. While labor-saving technology increases unemployment via a displacement effect, when sufficiently productive it can also create new labor-intensive tasks that reduce unemployment through a reinstatement effect. They find that the latter effect has been weak in US manufacturing in recent decades, resulting in employment losses.

Developing-world studies are somewhat sparser and tend to come from policy organizations. The aforementioned Chang and Huynh (2016) report from the ILO, which extrapolates the conclusions of Frey and Osborne (2013) to Cambodia, Indonesia, the Philippines, Thailand, and Vietnam, finds that 56% of all jobs in these countries are at a high risk of automation. The World Bank (2016) concludes that two-thirds of all jobs in the developing world are in principle liable to be automated, but cautions that low wages may prevent robots from outcompeting workers for some time yet. The World Economic Forum (2017) examines four Sub-Saharan African countries, finding that 44% of Ethiopian jobs are at high risk of automation, 52% of Kenyan jobs, 46% of Nigerian jobs, and 41% of South African jobs. The Asian Development Bank (2018) examines the impact of technological modernization in twelve Asian economies from 2005 – 2012. It finds that modern machinery and ICT displaced 101 million jobs per year on average but that resultant higher demand from the impact of these technologies created 134 million jobs per year. This result is especially interesting to consider in the framework of Acemoglu and Restrepo (2018); evidently the reinstatement effect dominated in these countries, arguably because the introduced technologies were highly productive. Frey, Osborne, and Holmes (2016) particularly emphasize that automation could abrogate developing countries' labor cost advantages in manufacturing, and thus their ability to achieve rapid catch-up growth. The Center for Global Development (2018) conducts a more thorough review of the literature and highlights key policy challenges for the developing world resultant from automation, including the threat of offshoring. It contends that analysis so far has been excessively technocentric, focusing on the potential automatability of tasks rather than the economic conditions for actual automation and its social consequences.

Given the vast uncertainty surrounding automation this thesis aims to provide policy advice on a high level. It aims to shed light on the viability of strategic responses to automation in the developing world in a manner that is agnostic of particular technological eventualities. Chapter II analyzes the political economy of industrial policy, which is likely to be a key component of retooling developing economies in the wake of automation. It deliberately uses a low-corruption setting – the European Union – to investigate the ways in which industrial policy can be politicized even in a best-case scenario. It highlights the need to remain cognizant of the incentives that industrial policy decision-makers face, which are likely to shape the allocation of funds. Chapter III conducts a case-study growth diagnostics analysis of the Vietnamese economy to explore one type of policy response to automation: prioritizing technology adoption to keep ahead of disruption. Vietnam is chosen because it is a classic export economy, is purportedly highly exposed to automation, and is a laggard on productivity growth. This chapter showcases the sorts of barriers to technological acceleration that developing countries may face, but also emphasizes the uniqueness of each country's circumstance and, accordingly, their optimal policy responses. Chapter IV draws upon product space methodology and machine learning to glean insight on another type of policy response to automation: specializing in economic activities less susceptible to reshoring. An algorithm is trained to forecast export upgrading based on how countries have previously grown, and then applied to a new product space which is altered to reflect the impact of automation. Sensitivity analysis is conducted across increasingly severe automation scenarios, which describes a general pattern of how automation may affect developing countries' export trajectories. Chapter V concludes and provides thoughts on future research directions.

Chapter II – The Political Economy of Industrial Policy

I. Introduction

A major tool for any country to readjust its economic production profile in anticipation of automation is industrial policy – that is, policy aimed to favor the development of particular industries. A wide range of specific mechanisms have historically been used in this way, from direct subsidy to preferential resource access. As will be detailed in this section's literature review, a major criticism of industrial policy is its subjectivity to political influence. Critics charge that more often than not, industrial policy becomes a form of corruption with net negative economic consequences. A newer literature counters that industrial policy can succeed if the policymaker is cognizant of his institutional environment.

This chapter uses one of the most easily quantifiable types of industrial policy, subsidy, to explore how industrial policy is politicized in a highly favorable environment – the relatively corruption-free European Union (EU). Shedding light on this matter, it is hoped, will permit more precise thought on the political incentives surrounding industrial policy generally.

One of the most important industrial policy tools in the EU is state aid, the provision of public funds to private enterprises. These funds are disbursed for a variety of espoused objectives from the conservation of traditional culture to the reduction of regional economic disparities. Since the 1980s the European Commission has developed more stringent regulation of state aid spending to discourage distortionary, anti-competitive subsidies, with a particularly large overhaul in 2005 that favors horizontal (economy-wide) over vertical (sector-specific) spending (Kassim and Lyons 2013). These supranational interventions have certainly made their mark: Kassim and Lyons note that the share of vertical spending in EU state aid declined from 39% in 2002 to 15% in 2010. Nevertheless, national governments retain some discretion over where to direct funds within the realm of objectives acceptable to the European Commission, and even broadly-defined programs may deliver funding to certain types of recipients more often than others. Nicolini, Scarpa and Valbonesi (2013) indeed contend that state aid in the European auto sector has been relabeled over time to fit European Commission standards, but is similar to previous interventions with more explicitly vertical objectives. Consequently there is scope for the politicized use of EU state aid.

This chapter will draw on new data from the European Commission to investigate why certain industries receive more EU state aid than others. Although the analysis does not address firm-level characteristics nor alternative industrial policy tools, it exposes some of the political economy incentives which are

strong enough to influence explicit industrial policy spending in democratic regimes even when tempered by pro-market, supranational regulation.

The rest of this chapter is organized as follows. Section II will conduct a review of the literature on how industrial policy spending might be captured or politicized. Section III will present this paper's hypotheses. Section IV will detail the econometric framework and data sources used, and Section V will present statistical results. Section VI discusses those results, while Section VII concludes.

II. Literature Review

A varied but straightforward set of conclusions have been made in the literature on how interest groups engage in political capture. Potters and Sloof (1995) survey empirical studies on how interest groups exercise political influence, concluding that groups with more members have more influence; that interest group campaign spending and lobbying alters legislation, especially that on niche issues; that being strongly affected by a policy improves a group's ability to influence it; that political allies and opponents respectively improve and reduce a group's influence; that interest group influence is lowered by stronger electoral competition and a more informed electorate; and that whereas corporate groups typically seek to change the minds of legislators, labor groups both persuade oppositional legislators and support allied ones. Dür (2008) reviews theoretical and empirical findings on interest group influence in the European context. He observes that scholars expect an interest group's resources (monetary, political, and informational), composition, and geographic concentration to affect its influence. The availability of resources from competing sources is expected to reduce how attractive that interest group is to political actors, while groups are theorized to most successfully influence low-visibility issues with a narrow set of beneficiaries and broadly dispersed costs. Empirical findings are mostly contradictory. In certain cases large business groups are found to strongly influence EU policy, while in others they only hold clout over technical aspects of policy as opposed to core ideas. Diffuse interests are likewise found to be influential on some EU policies such as environmental protection, but ineffective on others such as trade. The exact strategies of interest groups in the EU are ill-defined, although it is agreed that they lobby both national and supranational political actors.

Industrial policy has repeatedly been linked to politicization theoretically and anecdotally, but rigorous empirical evidence on the channels through which it occurs is lacking. Ades and Di Tella (1997) analyze business perceptions of measures related to industrial policy for a panel of sixteen countries over four

years, concluding that countries which employ more industrial policy experience more corruption. Auty (1995) argues that infant industries targeted for industrial policy in growing Taiwan and South Korea did not mature at efficient rates, indicating that they partly sustained themselves off captured public funds. Robinson (2009) relates instances of industrial policy being used as a political tool in post-colonial Ghana and Zambia, where investment was targeted towards areas with strategically important voters. Loewe (2013) finds anecdotal evidence that large Egyptian firms were, in some instances between 2004 and 2011, able to corruptly capture industrial policy funds, and that non-corrupt spending preferentially targeted national export champions which could be primed to easily boost exports.

The literature specifically investigating the political economy of EU state aid is especially sparse. Bergström (1998) uses a logit model of funding receipt to study the characteristics of Swedish firms given regional aid in 1989 and 1992. He finds mixed evidence that firms with more employees more often obtain aid and evidence in favor of younger firms receiving aid more frequently. Firms in industries which employ a high proportion of workers are found to receive aid more often, and it is ambiguous whether an industry with declining output has a higher probability of receiving aid. Firms without financial problems are found to be likelier to receive aid. Nicolini, Scarpa and Valbonesi (2013) examine summary statistics concerning EU state aid to the auto industry from 1990 to 2008, not only arguing that much vertical spending has simply been relabeled to fit the European Commission's standards but that "new national champion" firms which, regardless of national ownership, are visible in the economy and can plausibly create jobs are frequent targets for funding. Gual and Jódar-Rosell (2006) look at governmental variables, finding that more state aid is disbursed when chief executives have been in office longer, when governments are weaker, and when non-centrist parties hold office. Dewatripont and Seabright (2006) focus on the relationship between politicians and the electorate, developing a theoretical model wherein state aid spending, even if economically wasteful, is an effective mechanism for signaling the effort of politicians which voters rationally reward; the visibility of the state aid's recipient and impact thus act as important incentives.

III. Theoretical Framework

By nature state aid is ultimately disbursed to a set of firms. Assuming that governments are self-interested, state aid will be directed to firms with characteristics or resources that politicians find useful. This can either occur through political capture, where firms explicitly lobby to trade resources for state aid, or simply the politicized allocation of state aid, where governments take the initiative to disburse

funding where it will improve their re-election prospects. In any case a sort of exchange transpires where firm-associated resources, however tangible, are leveraged for state aid.

Some of these resources are likely to be distributed unevenly among different industries, such that firms in certain industries have a higher endowment of resources with which they can bargain. Other resources may be more uniformly distributed among industries. Both individual firms and groups thereof could feasibly enter the bargaining process. Assuming that firms in the same industry have more similar policy preferences, it would make sense for groups of firms which bargain for state aid to originate most often from the same industry. Industry associations indeed often bargain for policy changes in practice. Summing to the industry level, one would observe a collection of firms and subgroups thereof in each industry with similar preferences and resource endowments. The state aid allocated to the industry as a whole should thus be proportional the resource endowment of the industry, perhaps mitigated by other industry- or country-specific characteristics such as organizational cohesion or political institutions. Imagine, for instance, that firms in two industries compete for state aid using a resource valued by the government. Ceteris paribus one would expect the industry with more of the resource in aggregate to receive commensurately more state aid, whether this surplus is a result of industry-specific characteristics or sheer scale. As indicated by the literature, there are many possible resources which could be tapped to obtain state aid in practice. Herein hypotheses concerning several of the resources which seem most prominent and testable will be formulated.

If EU politicians benefit from signaling their effort and creating the perception of generally good economic performance they may benefit from disbursing state aid to national champion industries. Firms in highly productive, internationally competitive industries are plausibly perceived as more important to economic health and progress, and may be featured more in media. One can suppose that German voters, for example, may pay more attention to the export-oriented auto manufacturing than the tourism industry, and accord more weight to it in assessing the German economy. Politicians may thus deliver more assistance to such industries, both so those industries perform well and so politicians are seen as supportive of them. The first hypothesis follows:

Hypothesis 1: EU governments give more state aid to industries in which their country is more export-competitive.

Alternatively, politicians may seek rewards for state aid spending related to the financial power of recipients, such as campaign contributions and a recipient's influence on supply chain partners. If this is the case hypothesis 2 should be validated.

Hypothesis 2: EU governments give more state aid to industries with high levels of output.

If voters care about the level of funding allocated to the industry in which they are employed - which may, for instance, improve their job security or salary - then politicians may direct state aid to industries with high shares of employment.

Hypothesis 3: EU governments give more state aid to industries with high numbers of employees.

Finally, industries in decline may be able to make a good case for requesting state aid. Supporting a declining industry not only signals that a politician works hard to assist vulnerable segments of the economy, but directly improves the job security of those employed in such industries. Decline can be measured by a long-term decrement of any of the measures discussed in the previous three hypotheses.

Hypothesis 4: EU governments give more state aid to industries in decline.

IV. Econometric Framework and Data Description

A. Econometrics

The dependent variable, the amount of state aid received by an industry, is empirically expressed as the total state aid received by an industry, coded at the NACE A64 level, as a fraction of its home country's GDP. Expressing state aid as a fraction of GDP facilitates international comparison, while the NACE A64 industry classification scheme is used because it strikes an appropriate level of cohesion for analyzing sectoral industrial policy[1]. Explanatory variables are likewise converted to the NACE A64 level, and standardized around zero when continuous for interpretability. An industry's share of output (strictly

[1] For example, there are relatively more groupings related to manufacturing, such that the manufacture of chemicals is distinct from the manufacture of pharmaceuticals or plastic products; and fewer groupings in more uniform sectors, such that the farming of both poultry and rice are classified together as crop and animal production.

speaking gross value added) and employment among all industries in that country are used to represent its output and employment levels respectively, corresponding to Hypotheses 2 and 3. The independent variable from Hypothesis 1 is formulated as an industry's Revealed Comparative Advantage (RCA), calculated according to the standard formula by Hidalgo et al. (2007) but applied at the industry rather than product level. For each country i and industry j, where X is exports:

$$RCA_{ij} = \frac{X_{ij} / \sum_i X_{ij}}{\sum_j X_{ij} / \sum_i \sum_j X_{ij}} \tag{1}$$

RCA is, in other words, the ratio of a national industry's share of exports in its home economy to the share of worldwide exports accounted for by that industry globally. This measure is used because it captures how an industry's exports are performing relative to national and international peers. Non-export industries are assigned an RCA of zero. This is appropriate given that in this context RCA is used to measure an industry's international export competitiveness; export champions will have a high RCA, middling export industries will have a low RCA, and non-export industries with have a zero-valued RCA, which forms a sensible continuum.

Independent variables from Hypothesis 4 are constructed either as continuous or dummy variables. In the cases of output and employment, whether an industry is in decline is determined by fitting a linear trendline to that industry's share of the variable over a ten-year timespan. The slope of the trendline is extracted and used as the explanatory variable. This cannot be done for RCA due to the existence of non-export industries. Although one might think to assign these industries a slope of zero given that their export competitiveness does not change, this assumes that the effect of an industry not exporting on state aid is intermediate between an export industry with a declining RCA and an export industry with a growing RCA. It is in fact ex ante unclear how the effect of an industry not exporting should relate to the other two situations. Given the aim of theoretically capturing whether an industry's export competitiveness is in decline, a dummy variable is constructed instead which is 1 when the 10-year RCA trendline slope is negative and 0 for all other observations.

Since only one year of state aid data is available the main econometric specification uses the following cross-sectional model:

$$SA_{ij} = \beta_0 + \beta_1 X_{1,ij} + \cdots + \beta_n X_{n,ij} + \gamma Y'_i + \varepsilon_{ij} \tag{2}$$

Where i and j represent country and industry respectively, SA_{ij} is the state aid received by industry i in country j as a proportion of that country's GDP, each $X_{k,ij}$ is an explanatory variable observed for industry i in country j, Y'_i are country fixed effects, and ε_{ij} is the error term. Input variables are lagged to mitigate endogeneity concerns.

One might contend that industry fixed effects would also be important to include in the main specification. The case for country fixed effects, however, seems substantially stronger: countries almost certainly have preferences which affect the way they spend state aid across all industries, whereas industries can vary considerably across different countries and may not produce uniform effects. As such industry fixed effects are used as a robustness check rather than as an element of the main specification.

B. Data

State Aid data is provided by the European Commission's State Aid Transparency Database. All types of aid objectives are included, which is especially important given that previous authors note how the explicitly reported objective of state aid may not correspond to its true purpose. As of July 2016 all EU countries were required to report any sizeable disbursements of public funds to private entities on this database, including the amount given and the NACE sector of the recipient; consequently the first full calendar year of data – for 2017 – is available as of the time of writing. Despite this legal requirement some countries unfortunately have failed to upload data so far, and are thus excluded from this analysis. Countries with populations under 1 million are also dropped, as such microstates are likely to follow unusual economic trajectories which could bias statistical results. As a consequence this analysis covers Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, the Netherlands, Portugal, Slovakia, Slovenia, Sweden, and the United Kingdom for the year 2017. A major consequence of the limited temporal coverage of the data is that this analysis represents a particular snapshot in time that is unable to comment on trends.

The raw state aid data is cleaned to drop observations for which no fund award value is reported (3% of observations), and to convert award values reported as a range to the mean of that range (e.g., from 50,000 - 100,000 Euros to 75,000 Euros). Firm-level state aid is then summed to the industry level, converted to US dollars, and divided by GDP in US dollars as reported by The World Bank.

Export data is sourced from the Harvard Observatory of Economic Complexity, while output and employment data is provided by Eurostat. The most recent year for which data was available for all independent variables, 2015, is used. Export data is converted from HS 1992 to NACE A64 classification using correspondence tables from The World Bank and Eurostat, in the process of which 3% of original observations are lost due to incomplete matching. Observations for which Eurostat does not report output or employment statistics are dropped.

V. Results

After discarding a small number of high-impact outliers[2] a series of robust OLS regressions are performed with the goal of avoiding multicollinearity among explanatory variables. First the RCA, output share, and employment share are examined in isolation. Squared terms are included to more rigorously investigate Hypotheses 1-3; one may suppose that there could be optimal levels for these variables. Results of the first regressions are shown in Table 1.

The most interesting finding from these regressions is that, as per the signs and magnitudes on the RCA and RCA squared terms, there are first sharp increasing and then declining returns to RCA for the receipt of state aid. It appears that export industries with a small comparative advantage receive more state aid than non-export industries, and that they receive less state aid as their comparative advantage grows. Also of note is the fact that an industry's share of employment does not appear to affect state aid, and that multicollinearity between the share of output and its square (which have the same sign and correlate highly) dissipates the significance of an industry's output share in specifications 6-8. One can therefore take specification 5 as the main result from Table 1.

Next trend-related variables are examined in isolation, with results reported in Table 2. The insignificance of the employment share's slope lends further weight to its unimportance in explaining industry-wise state aid allocation, while the consistent significant positive effect found for export industries with declining RCA reinforces the importance of the exports narrative.

Given the prior result that small-RCA export industries receive more state aid than large-RCA export industries one might wonder if a declining RCA affects both groups equally. Consequently several

---

[2] A handful of industries, generally from smaller countries, have especially high leverage and are discarded.

dummy variables corresponding to these four situations are constructed for the next regression (continuous variables are avoided because their interaction with dummies here creates multicollinearity). Industries are categorized as having a small RCA if their RCA is below the average RCA among export industries; they are categorized as having a large RCA if their RCA is above that average.

Each of these two dummies is interacted with the export decline dummy to create a further two variables to represent small-RCA industries in decline and large-RCA industries in decline. Results are shown in Table 3. Consistent with results in Table 1, there appear to be bigger effects for small rather than large-RCA export industries. It also seems that large-RCA export industries receive more state aid when their RCA is declining, but that this does not occur for small-RCA export industries. A small amount of multicollinearity appears in specification 2, which disappears thereafter when more sharply contrasting variables are introduced.

The main results thus far – the dummies from Table 3, plus the output share variable from Table 1 – are put together in Table 4 for robustness checks. Two checks are done specifically on the export narrative. In specification 2 each industry's share of total exports is examined, and in specification 3 each industry's labor productivity (computed as its share of output over its share of employment) is introduced. In the former case one could imagine bias being introduced because export industries might receive more aid if they simply export more rather than being internationally competitive. In the latter one could imagine that comparative advantage was simply a proxy for productivity, which the state cares about regardless of whether an industry is domestically- or internationally-oriented. Neither of these checks alter the main results, however. The final robustness check, which introduces industry fixed effects, actually appears to enhance the strength the export-related findings while dissipating the significance of the output share variable. It is plausible, however, that this change is attributable to multicollinearity, such that output share could be highly dependent on the type of industry regardless of country.

The evidence to support Hypothesis 1 seems fairly strong, and we can thus consider it validated. Hypothesis 2 may be partially validated; although output is significant in the main specification it is not robust to the introduction of industry fixed effects. There is no evidence to support Hypothesis 3, which is consequently rejected. Hypothesis 4 is validated with respect to export competitiveness, with the caveat that the importance of industrial decline only appears to apply to large-RCA industries.

Table 1. Resource Amount Results.

	(1)	(2)	(3)	(4)
RCA	0.039***			0.095***
	(0.013)			(-0.065)
RCA^2				-0.065***
				(0.017)
Output Share		0.023**		
		(0.010)		
Output $Share^2$				
Employment Share			0.002	
			(0.007)	
Employment $Share^2$				
Constant	-0.121***	-0.115***	-0.115***	-0.131***
	(0.006)	(0.006)	(0.005)	(0.009)

	(5)	(6)	(7)	(8)
RCA	0.098***	0.099***	0.095***	0.095***
	(0.020)	(0.020)	(0.020)	(0.020)
RCA^2	-0.068***	-0.068***	-0.066***	-0.066***
	(0.018)	(0.018)	(0.017)	(0.018)
Output Share	0.026**	0.015	0.046	0.025
	(0.010)	(0.021)	(0.028)	(0.038)
Output $Share^2$		0.012	-0.007	0.007
		(0.028)	(0.029)	(0.035)
Employment Share			-0.020	0.021
			(0.013)	(0.041)
Employment $Share^2$				-0.036
				(0.030)
Constant	-0.131***	-0.131***	-0.131***	-0.132***
	(0.009)	(0.009)	(0.009)	(0.009)

Notes: Regression coefficients reported. White-corrected standard errors reported in parentheses.

*** Significant at the 1 percent level; ** significant at the 5 percent level; * significant at the 10 percent level.

Table 2. Resource Trend Results.

	(1)	(2)	(3)	(4)	(5)
RCA Decline	0.194***			0.196***	0.198***
	(0.044)			(0.045)	(0.044)
Output Trend		0.001		0.006	0.001
		(0.008)		(0.008)	(0.010)
Employment			0.003		0.010
Trend			(0.009)		(0.011)
Constant	-0.143***	-0.115***	-0.115***	-0.143***	-0.143***
	(0.011)	(0.005)	(0.005)	(0.011)	(0.011)

Notes: Regression coefficients reported. White-corrected standard errors reported in parentheses.

*** Significant at the 1 percent level; ** significant at the 5 percent level; * significant at the 10 percent level.

Table 3. Export Trend Interaction Results.

	(1)	(2)	(3)	(4)
Small RCA	0.215***	0.211	0.250*	0.250*
	(0.074)	(0.131)	(0.131)	(0.131)
Small RCA in Decline		0.009	0.009	0.009
		(0.148)	(0.147)	(0.147)
Large RCA			0.152***	0.108***
			(0.027)	(0.019)
Large RCA in Decline				0.102**
				(0.050)
Constant	-0.129***	-0.129***	-0.182***	-0.180***
	(0.009)	(0.010)	(0.015)	(0.015)

Notes: Regression coefficients reported. White-corrected standard errors reported in parentheses.

*** Significant at the 1 percent level; ** significant at the 5 percent level; * significant at the 10 percent level.

Table 4. Robustness Checks.

	(1)	(2)	(3)	(4)
Small RCA	0.272**	0.275**	0.272**	0.318***
	(0.131)	(0.131)	(0.131)	(0.115)
Small RCA in Decline	0.009	0.007	0.009	0.035
	(0.147)	(0.147)	(0.147)	(0.145)
Large RCA	0.121***	0.138***	0.121***	0.200***
	(0.019)	(0.022)	(0.019)	(0.029)
Large RCA in Decline	0.104**	0.101**	0.103**	0.100**
	(0.050)	(0.050)	(0.050)	(0.042)
Output Share	0.038***	0.039***	0.038***	0.0234
	(0.010)	(0.011)	(0.011)	(0.023)
Export Share		-0.307		
		(0.228)		
Productivity			0.00	
			(0.003)	
Constant	-0.186***	-0.187***	-0.186***	0.069
	(0.015)	(0.016)	(0.016)	(0.239)
Industry Fixed Effects	No	No	No	Yes

Notes: Regression coefficients reported. White-corrected standard errors reported in parentheses.

*** Significant at the 1 percent level; ** significant at the 5 percent level; * significant at the 10 percent level.

VI. Discussion

As previously noted, a major goal of the European Commission's approach to state aid in recent years has been to reduce the distortion of industrial competitiveness. The results herein, however, support the contention of some prior authors that boosting export competitiveness - however artificial that may be - remains a significant incentive for European governments, even if it is masked by alternative labeling. While this paper's findings certainly do not preclude alternative motivations for state aid spending, they indicate that EU states are, broadly speaking, driven to support export competitiveness by funding small-RCA industries (presumably seen as having potential for growth) and large-RCA industries in decline (presumably to preserve their dominance). There is some evidence that EU

politicians are also motivated to fund large-output industries, possibly in exchange for financial support or political influence over the wider economy, but this finding is not always significant and its coefficient is always smaller than that for RCA-related measures.

Notably, this combination of results suggests that the politicized distribution of EU state aid is less driven by explicitly-corrupt political capture than the re-election incentives politicians face. If output or employment levels had been more strongly related to state aid it may have been possible to argue that politicians use state aid to buy campaign donations or votes, but it is hard to imagine how export competitiveness could be used to directly fill coffers or ballot boxes. It is far more plausible that export competitiveness is funded in order to create perceptions of economic health (justified or not), a consequently good image for incumbent politicians, and ultimately improved re-election prospects. This adds nuance to previous arguments such as Ades and Di Tella (1997) that industrial policy becomes easily entangled in corruption; it may be the case that sufficiently high institutional quality, as generally seen in the EU and augmented by supranational oversight, mitigates resultant corruption, such that this effect is primarily driven by countries with lower institutional quality.

New Industrial Policy literature (see Rodrik, 2004) argues that effective industrial policy needs to be designed with institutional constraints in mind. These political economy findings thus have important policy design implications. Policymakers in the EU (or other high-income democracies to which these results may be externally valid) may, for instance, want to introduce rules concerning the proportion of industrial policy funds that can go to different categories of export industries to promote more horizontal spending, or design programs which are most likely to be useful to probable fund recipients. Developing-world policymakers should note that efforts to improve their country's institutional quality may allow it to exercise industrial policy more aggressively. They should also observe how EU politicians are incentivized to maintain power by convincing voters that they're managing the economy well. There are undoubtedly alternative channels through which developing-country politicians maintain power, and it would be unsurprising if industrial policy expenditure was directed accordingly.

Although these findings seem robust within the set of countries considered (and, though not reported here, subsections thereof) they should be interpreted with some caution. To begin with the observed data is incomplete, as some EU countries have apparently not yet reported their spending in 2017. Important peripheral economies like Spain, Italy, and Poland are not considered, and it is plausible that their behavior could differ from the better-represented Northwestern European states. Moreover, the scope of this analysis specifically covers industry-level variation in state aid in the EU in the year 2017.

Other forms of industrial policy exist; differences between firms are almost certainly an important determinant of state aid flows; and these results cannot be easily statistically compared to historical behavior. Although it appears that boosting export competitiveness is an important source of industry-level variation there are undoubtedly other political economy factors which influence European industrial policy spending with similar or greater efficacy, and it may be that the European Commission's efforts to stymie vertical spending have reduced the funds allocated towards export competitiveness.

VII. Conclusion

This chapter uses new data from the European Commission to investigate the political economy factors which motivate the industry-wise distribution of state aid spending in the European Union. Specifically, the total state aid each industry receives as a proportion of GDP is hypothesized to be influenced by an industry's export competitiveness, share of output, share of employment, and possibly the decline of these measures. Relatively robust evidence is found in favor of the export competitiveness narrative. It appears that exporting industries with a small Revealed Comparative Advantage receive a high proportion of state aid, while export industries with a large Revealed Comparative Advantage receive a somewhat lesser proportion. The latter type of industry receives more state aid when its Revealed Comparative Advantage is in long-term (ten-year) decline. There is also some evidence that an industry's share of output influences the amount of state aid it receives, although this effect is smaller in magnitude than those associated with exports and is not significant in all specifications.

These findings support the views of some authors such as Nicolini, Scarpa and Valbonesi (2013) that European state aid remains at least partly targeted towards specific industrial sectors despite the European Commission's efforts to disburse it on an economy-wide basis. Given that the support of export competitiveness is better explained by the re-election incentives politicians face than overtly corrupt political capture these findings also partly rebut the narrative of industrial policy necessarily leading to corruption as per Ades and Di Tella (1997).

Further research in the European context could use the state aid data reported by the European Commission to more closely examine firm-level variation in state aid allocation at the EU level. Analysis of other industrial policy tools would likewise be informative, if difficult to construct data for. The possibility that institutions affect the extent to which industrial policy creates corruption could be

investigated with the use of data from other parts of the world. Finally, these findings should be confirmed as more firm- and industry-wise EU state aid data becomes available.

Chapter III – Accelerating Technological Change in Vietnam

I. Introduction

The Growth Diagnostic Framework

This chapter draws upon the growth diagnostic methodology of Hausmann, Rodrik, and Velasco (2008) to investigate the biggest barriers to technological progress in Vietnam as a case study. By delving into the binding constraints to technological advancement in a developing country I aim to shed light on the sorts of policy levers that may be effective for the elimination of such barriers broadly. Vietnam is selected because it is a quintessential example of a developing country that uses export-led growth and is considered by some, such as Chang and Huynh (2016), to be highly exposed to automation.

The growth diagnostic framework is especially useful for this purpose because it permits one to investigate economic issues that are highly specific to a particular country. While general approaches such as cross-country regression analysis may reveal variables that are broadly correlated with the outcome of interest, they often mask substantial detail which has great expository power for the task at hand. For example, increasing R&D spending might be shown to correlate with productivity growth across a broad selection of countries. However, this does not ensure that it is the correct policy tool for a particular country's situation, and moreover such a result does not elucidate the detailed mechanisms that hold back productivity growth for any given country and thus limits our explanatory understanding. Instead, the growth diagnostic approach seeks to identify specific factors which hold back a country's growth. There are generally four methods with which one can identify if a constraint is binding:

1. **Check if movements in the constraint produce significant movements in the outcome variable.** For example, if low-quality roads critically hold back a country's growth then investment in or destruction of roads should be associated with noticeable swings in growth rates.
2. **Check if the price (or shadow price) of the constraint is high.** If difficulty accessing a certain good critically holds back growth, then high demand and low supply should ensure that its price is high. If a price in monetary terms is not available other indicators of high demand and low supply – "shadow" prices – can be used. For example, if businesses frequently report that insufficient access to a particular good stymies their growth that measure may be taken as a shadow price.
3. **Check for the relative absence of agents intensive in the scarce, expensive factor of production and the abundance of agents that are not intensive in the factor.** If water is scarce, then camels

should thrive while hippos perish. Similarly, businesses which are very reliant on a scarce factor of production should generally fail while those which specialize away from it should do better.

4. **Check if agents display behavior which indicates they are compensating for the constraint.** A wealthy hippo may survive in the desert if it can pay for a private water supply – but when water is abundant it wouldn't do so. Likewise, a factory with sufficient capital endowments might invest in a private generator if and only if the public power supply is very poor.

This framework is used to analyze the economy in increasing levels of detail. One might start with high-level macroeconomic problems, and then move to the microeconomic issues which underlie them with increasing specificity. With that in mind, the remainder of this chapter will first consider Vietnam's growth trajectory in an aggregate sense before delving into sections of the economy and the structural issues that hold them back.

History of Vietnam

Vietnam is a densely-populated Southeast Asian country with a tumultuous history. It was ruled by the Chinese Empire for a millennium (111 BC - 938 AD), and after nine hundred years of subsequent independence came under the dominion of the French Empire (1858 AD - 1945 AD). The First Indochina War of independence (1946 AD - 1954 AD) left the country divided between Ho Chi Minh's communist regime in the north and a US-backed capitalist regime in the south, the former of which was ultimately to prevail in the Vietnam War (1954 AD - 1974 AD). Forced collectivization and harsh crackdowns on perceived market elements proceeded, resulting in economic collapse.

Faced with the stark economic consequences of central planning and the winding down of the Cold War, Vietnamese leadership embarked on a series of market reforms known as "Doi Moi" - meaning "renovation" - commencing in 1986. Over time private agriculture was reinstated, competition between private and public companies was encouraged in non-strategic sectors, and the country was opened up to foreign investment.

Economic Position

As a consequence of Doi Moi Vietnam's GDP per capita soared from $230 at its outset to $2,300 in 2017. Its GDP per capita growth rate over this period has been very strong, at one of the highest rates in the region and the world; nevertheless, it has not been as high as the growth seen following the Chinese

market reform from 1978 nor the Korean reform from 1961 (Figure 1). The key driver of this growth has been structural transformation, drawing employment out of agriculture into much higher-productivity export-oriented manufacturing (Figure 2). Vietnam did not begin the period with the facilities for such exports, and its growth trajectory can thus also be viewed as a story of capital accumulation at a more macro level (Figure 3).

Quick Facts

Population (2017)	GDP per Capita (2017, USD)	GDP Growth (2017)	Gini Index (2014)	% Urban (2017)	% Labor Force in Agriculture (2017)	Mean Years of Schooling (2015)	Exports, % of GDP (2017)	Effective Governance % Rank (2016)
95.5 Million	$2,343	6.8%	34.8	35%	40%	8.0	102%	53%

Decomposing the nature of Vietnam's export growth, it is apparent that textiles, electronics, and at times petroleum products have dominated (Figure 4). In this process Vietnam has successfully diversified in terms of particular products but specialized within certain industries, as indicated by Herfindahl indices of export composition at the four- and two-digit HS level respectively (Figure 4).

Figure 1. Vietnamese Income Growth vs. Selected Peers. (Source: World Bank)

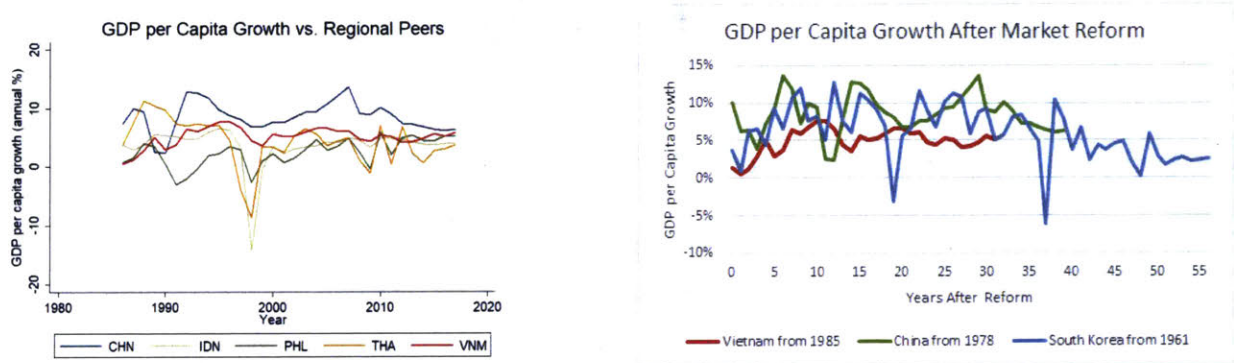


Figure 2. Vietnamese Structural Transformation. (Source: World Bank)

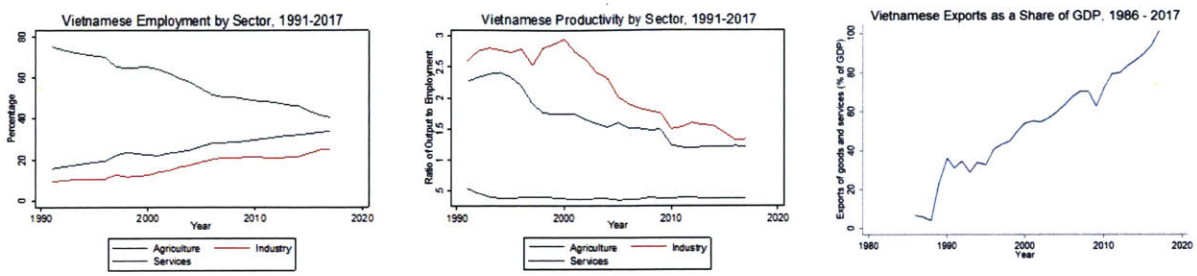


Figure 3. Vietnamese Capital Accumulation. (Source: World Bank)

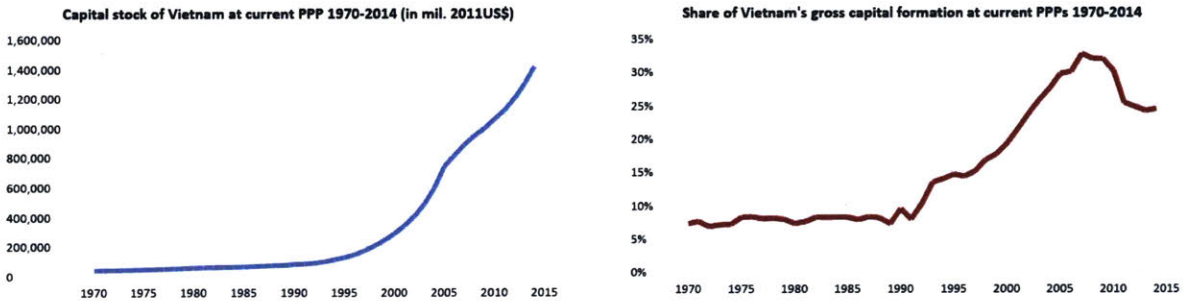
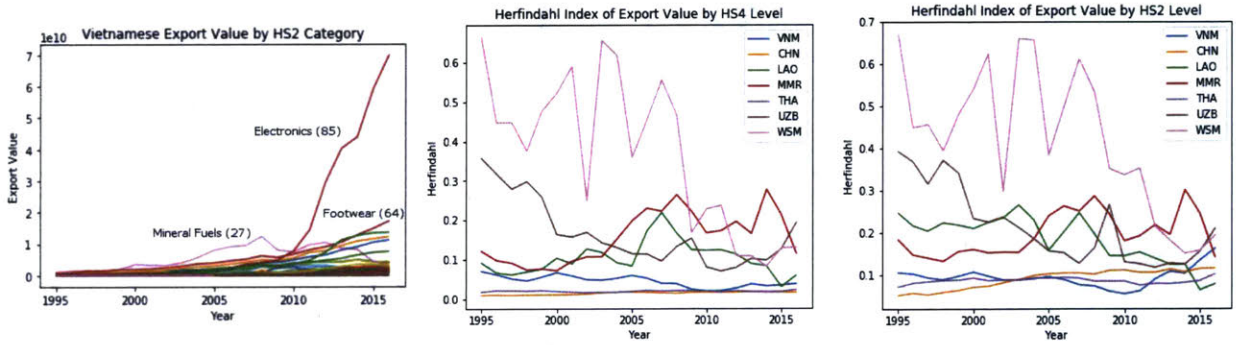


Figure 4. Vietnamese Export Growth vs. Selected Peers. (Source: Harvard Atlas of Economic Complexity)



Commensurate with this spectacular explosion of exports in the strategic sectors of textiles and electronics has been an ascension of the economic complexity ladder (Figure 5). Vietnam now has a high Complexity Outlook Index (COI) for its Economic Complexity Index (ECI) score – measures developed by Hausmann and Hidalgo (2009) which mean that it is especially well-positioned to move into more complex, higher-value exports given its current export portfolio (Figure 6).

The social ramifications of central planning followed by modernization have been profound and, in some respects, unbalanced. Vietnam has has had a persistently high life expectancy and low fertility rates, with the result that it is expected to age very quickly in the coming decades (Figure 7). While primary and secondary education levels are generally excellent for its income level, tertiary education lags behind (Figure 8). Urbanization is, furthermore, relatively incomplete - 35% of Vietnamese are urban, and 40% of the country still works in agriculture - and the concentration of industrialization around major urban centers in the north and south has created noticeable regional disparities in income (Figure 9).

Figure 5. Vietnamese Product Space Evolution. (Source: Harvard Atlas of Economic Complexity)

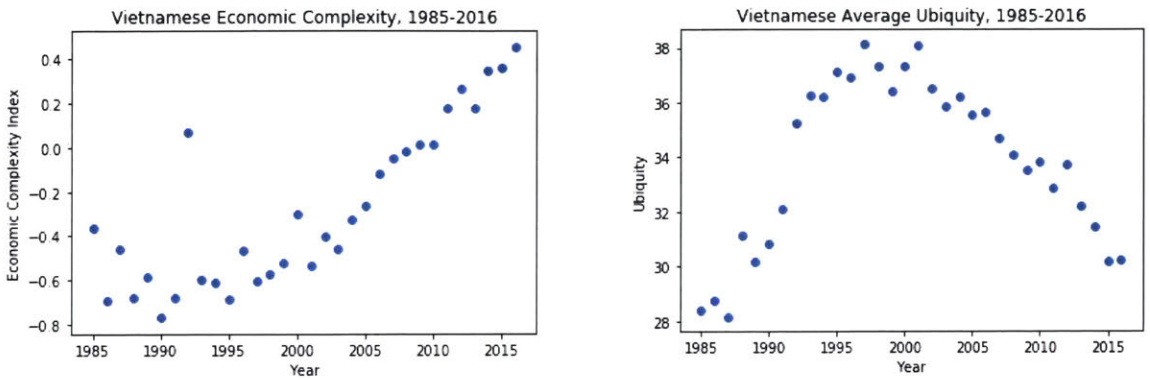


Figure 6. Vietnamese Complexity Outlook. (Source: Harvard Atlas of Economic Complexity)

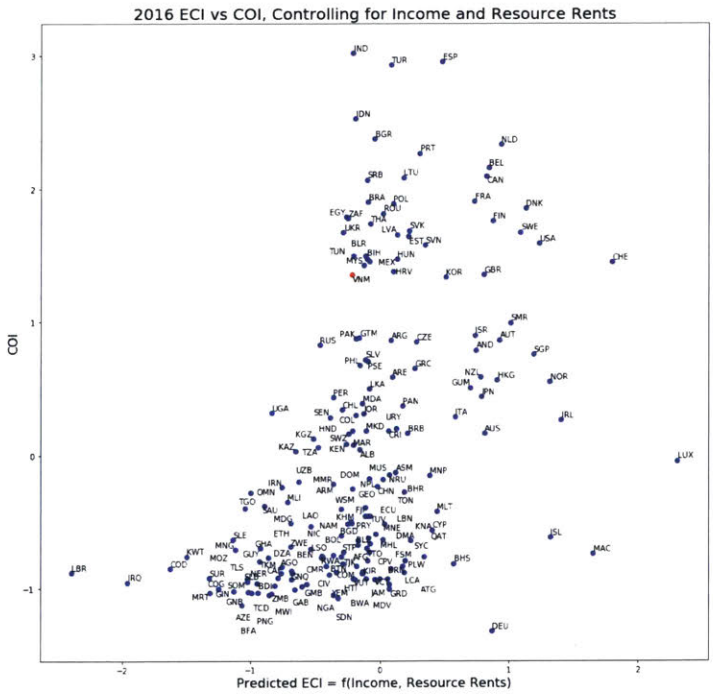
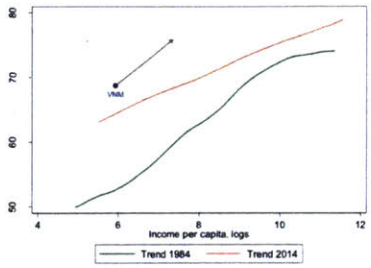
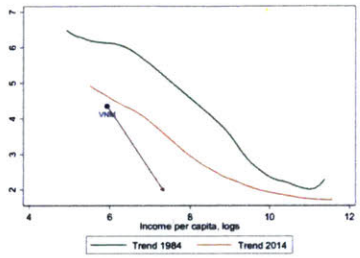


Figure 7. Vietnam's Ageing Demographics. (Source: World Bank, United Nations)

Life Expectancy vs. World



Fertility vs. World



Dependency Ratio Projection

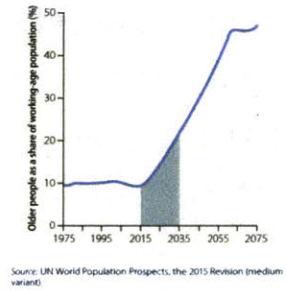
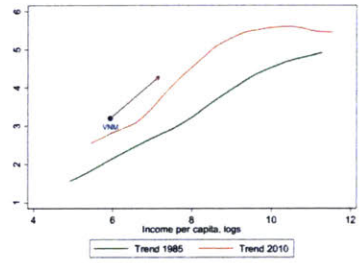
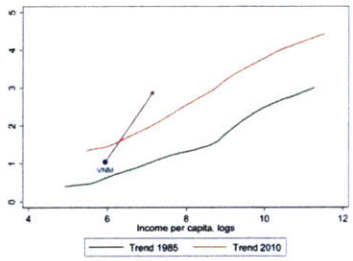


Figure 8. Vietnamese Education Levels. (Source: World Bank)

Years of Primary Education vs. World



Years of Secondary Education vs. World



Years of Tertiary Education vs. World

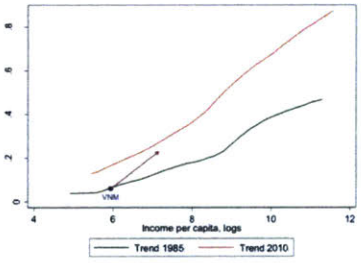
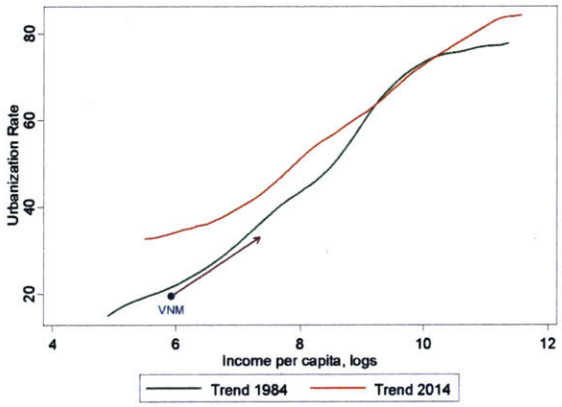
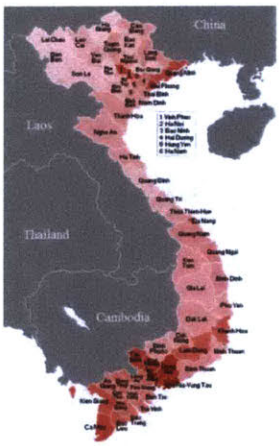


Figure 9. Vietnamese Urbanization Patterns. (Source: World Bank, General Statistics Office of Vietnam)

Urbanization vs. World



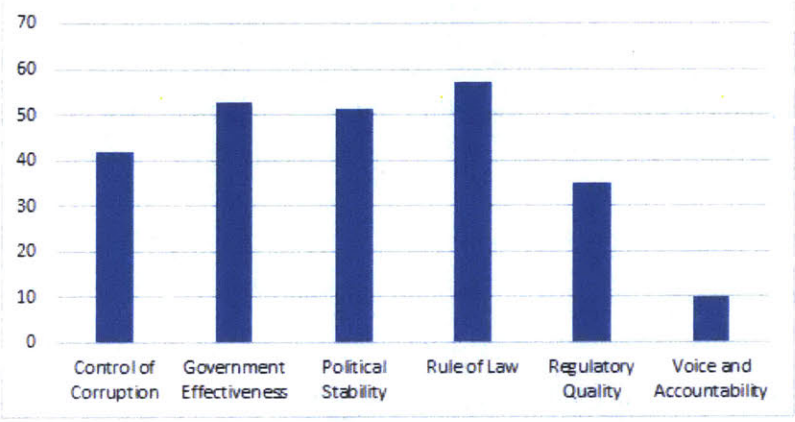
Income Heatmap



Political Economy

Vietnam is a one-party socialist state. It does not perform well in governance indicators (Figure 10). Vietnamese leadership is essentially motivated by the need to maintain legitimacy and does so through a mixture of economic growth and political repression. The latter is naturally antithetical to the former, and so reform proceeds in stops and starts with occasional reversals.

Figure 10. Vietnamese Governance Indicators, 2016 (% Rank). (Source: World Bank)



Formally, executive power in Vietnam is distributed between the offices of the President (the head of state), the Prime Minister (the head of government), and the General Secretary of the Communist Party (the party leader) while legislative power is allocated to the National Assembly. In practice, the National Assembly is a rubber-stamp institution which abides by the direction of the Communist Party. For most of the Doi Moi era, there was a relative balance of de facto power between competing powerbrokers in Vietnam, and in recent years in particular there was a competition for power between Prime Minister Nguyen Tan Dung (2006 - 2016) and General Secretary Nguyen Phu Trong (2011 - Present) which prevented one-man rule[3]. Trong has won this internal struggle, however, and as of 2018 has additionally assumed the office of the President - making him only the third person in Vietnam's history to simultaneously hold both offices.

[3] https://thediplomat.com/2018/02/is-vietnam-going-the-way-of-china/

II. Vietnam's Growth Question

Vietnam is indisputably a major development success story, and with its GDP growth rate clocking in at 6.8% in 2017 it is clearly not presently constrained from expansion. Nevertheless, there are issues on the horizon which worry both commentators and Vietnamese policymakers, like an increasing old-age dependency ratio. Of particular concern to the Vietnamese authorities is that an estimated 70% of jobs are at a high risk of displacement from new automation technologies - the highest rate in Southeast Asia (Chang and Huynh 2016). If this forecast comes to fruition Vietnam, like many countries before it, may stagnate once it reaches middle income status. This is not only a sobering economic eventuality, but a political risk for a government that bases its legitimacy at least in part on the improving material lifestyle it cultivates for Vietnamese citizens.

Rather than discussing the risk of stagnation abstractly, it is best to turn to data to assess its severity. One method of determining the growth outlook of a country is by seeing how similar economies have fared before. Here I determine which countries in which years had the most similar export portfolios to Vietnam and map out their GDP per capita growth rates in the following decade (Figure 11). Specifically, the similarity of each country in each year is calculated by listing the exports in which each country has a Revealed Comparative Advantage; for each such export, obtaining the proximity score for the most similar export the other country has using an export proximity matrix; and averaging all such closest export proximities across both countries under consideration. The highest overall score for each country in any given year as compared to Vietnam in 2016 is tabulated, and the countries with the highest five similarities are noted. Their growth trajectories are then plotted (Figure 11), dropping the year 1998 seeing as growth during the Asian financial crisis was not representative of regular patterns.

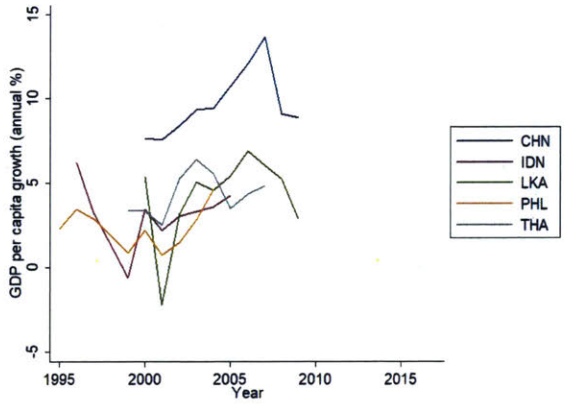
As can be seen, the ten-year growth trajectories of countries with similar export portfolios to Vietnam were generally strong. Nevertheless, there was substantial variation in their performance, with average GDP per capita growth rates ranging from 2.4% to 9.7%. This suggests that Vietnam's growth possibilities look positive, but that there are no guarantees and maximizing gains will probably depend on good policy. **The proximate growth question is thus: how can Vietnam sustain its growth?**

Deeper investigation of the Vietnamese economic growth suggests a budding macro-level class of problems which, given a decade or two to fester, could pose serious obstacles to further gains and prevent the technological upgrading needed to avoid the brunt of automation-driven export reshoring. Initial hints include professionally-published growth accounting exercises for Vietnam. Although growth

Figure 11. Export Comparators and Growth Trajectories. (Source: World Bank, Harvard Atlas of Economic Complexity)

Country, Year	Average Closest Proximity of MCP
Thailand, 1998	0.719
Indonesia, 1996	0.704
Philippines, 1995	0.696
China, 2000	0.695
Sri Lanka, 2000	0.684

10 Years' GDP per Capita Growth, Excluding 1998



accounting must always be taken with a hefty grain of salt[4], a sufficient number of results show such low productivity gains - which in some cases are even negative and negatively contributing to GDP growth in recent years - that more micro-founded investigation is warranted[5,6,7]. Data from the UNIDO INDSTAT database is thus used to assess the breakdown of manufacturing productivity growth in Vietnam. First, changes in manufacturing multifactor productivity are calculated in Vietnam and peers with available data by dividing changes in value added by the sum of gross capital formation and changes in wages paid (Figure 12). Vietnam is a clear laggard with by far the lowest multifactor productivity gains.

One might contend that this underperformance is due to natural structural factors that will amend themselves over time, but further inspection of data indicates this is not the case. Vietnam's low productivity growth is not attributable to being at lower income levels than comparators nor the presence of laggard industries which will gradually diminish in importance (Figure 13). Indeed, the

---

[4] Refer to the Cambridge Capital Controversy for commentary on the internal mathematical inconsistency of the Cobb-Douglas production function.

[5] https://ipsard.gov.vn/images/2007/07/Chat%20luong%20tang%20truong%20gui%20tu%20tokyo.pdf

[6] https://www.otago.ac.nz/economics/otago682041.pdf

[7] https://www.conference-board.org/data/economydatabase/index.cfm?id=27762

largest sectors in Vietnam are its champion industries, and thus its overall manufacturing productivity gains are representative of its most competitive sectors.

Figure 12. Changes in Manufacturing Multifactor Productivity, Vietnam vs. Peers. (Source: UN)

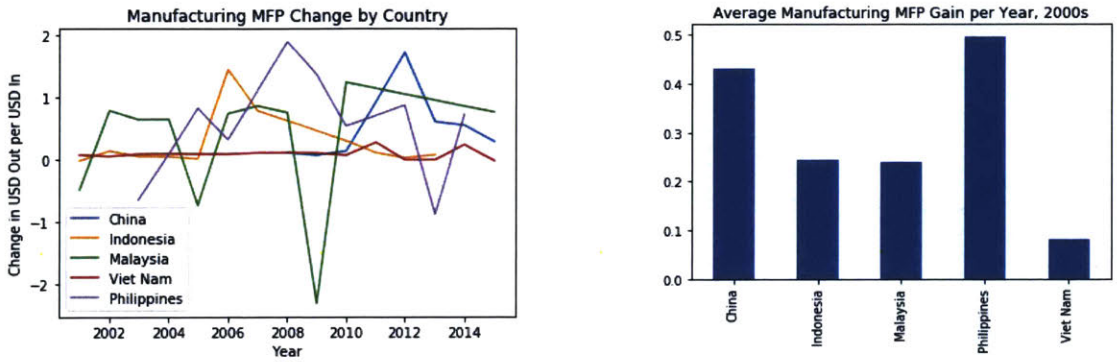
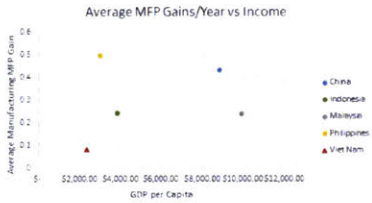
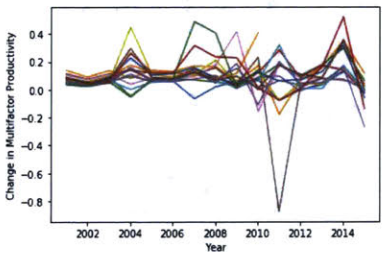


Figure 13. Investigation of Potential Explanations for Vietnam's Low Productivity Growth. (Source: UN)



Vietnamese MFP Change by ISIC 2-Digit Category



Fastest and Slowest Growing Industries in Vietnam by ISIC 2-Digit Category

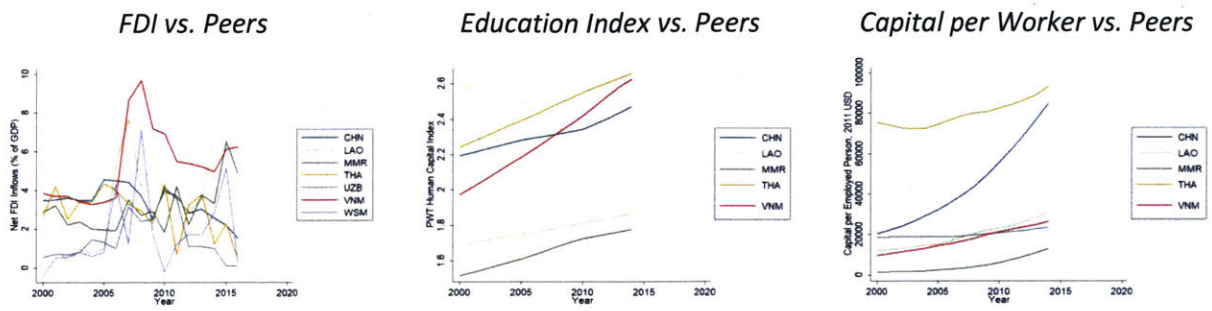
Top 3 Industries	Average MFP Gain
Motor vehicles, trailers, semi-trailers	0.121
Wearing apparel, fur	0.111
Furniture, manufacturing n.e.c.	0.105

Worst 3 Industries	Average MFP Gain
Paper and paper products	0.052
Printing and publishing	0.049
Textiles	0.033

One might in turn question why growth and investment have been so strong in Vietnam if productivity growth has been so persistently weak, but in fact this is entirely expected. It is typical for pre-middle income growth to be fueled by capital accumulation, and it is the transition to productivity-led growth which tends to mire countries in the middle income trap (Agénor, Canuto and Jelenic 2012). Thus far Vietnam's low capital stocks and decent education have ensured high returns to capital, so investment-led growth has not been a problem (Figure 14).

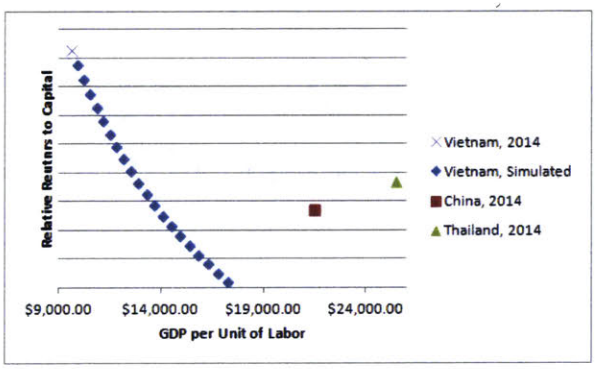
The consequences in terms of navigating automation are obvious. Productivity is an indicator of an economy's technology level, and stagnant productivity means Vietnam may be unable to upgrade its way beyond the impact of automation. Even without the threat of automation, however, this situation is troubling. While it is likely that FDI inflow and growth will remain strong in the near future, basic growth calculations show how easy it would be for Vietnam to fall into stagnation if it cannot accelerate its

Figure 14. Investment in Vietnam and its Enablers. (Source: World Bank, Penn World Tables)



productivity growth. In a worst-case scenario that assumes no changes in Vietnam's productivity, stock of human capital, or rate of capital accumulation the country's marginal productivity of capital converges to current Thai and Chinese levels within a decade - but at half the income per worker (Figure 15). At this point Vietnam would be hard-pressed to compete even for capital inflows against its wealthier peers, and GDP growth would conceivably sputter out.

Figure 15. Worst-Case Scenario Growth Accounting Simulation. (Source: Penn World Tables)



Given the persistence of Vietnam's low manufacturing productivity growth, the unlikeliness of its natural structural resolution, and the severity of its potential eventual impact on continued income gains, **the deeper growth question is: what constrains Vietnam's productivity growth?**

III. Tests for Binding Constraints

This section will investigate potential binding constraints for Vietnam's productivity growth. It is useful to bear in mind the following statistics about the performance of different firm types in Vietnam (Figure 16) to weight their relevance to this problem. The domestic portions of the economy, comprising State-Owned Enterprises (SOEs) and the domestic private sector, have very low return on asset rates despite accounting for more than 80% of Vietnamese capital. The FDI sector has a strong rate of return on assets, but - as seen in Figure 13 - even export-oriented champion industries have experienced slow productivity growth. Efforts to boost productivity growth in Vietnam thus ought to focus on fixing the domestically-owned portions of the economy and augmenting gains in the critical foreign-owned, export-oriented sector.

Figure 16. Characteristics of Firms by Type in Vietnam, 2016. (Source: General Statistics Office of Vietnam)

Firm Type	% Capital Stock	Capital per Firm	Workers per Firm	Return on Assets
FDI	18.1%	$15.5 Million	222	6.9%
SOE	28.4%	$129 Million	89	2.6%
Domestic Private	53.5%	$1.3 Million	16	1.4%

Several aspects of the economy which are often portrayed as problematic will be documented, in most cases concluding that binding constraints are absent. For convenience the most serious problem areas are generally presented first, with the first two areas - **State-Owned Enterprises (SOEs)** and **Human Capital** - constituting the major constraints on the domestic- and foreign-oriented portions of the economy respectively.

State-Owned Enterprises

From Figure 16 it is immediately apparent that SOEs in Vietnam are quite inefficient. Given the historical performance of central planning, it is unlikely that their productivity can be significantly augmented, and one may thus wonder why they merit attention for reform. After all, if other areas of the economy can be independently fixed up to grow quickly then the importance of SOEs would surely dwindle over time without presenting a binding problem. The trouble is that SOEs are not simply mandated to operate by

the Vietnamese government; they are given monopolies, subsidies, and preferential access to limited resources, and thus stymie the domestic private sector.

Although detailed microdata is very difficult to come by, the General Statistical Office of Vietnam does publish provincial breakdowns of firm and employee counts between the FDI, SOE, and Domestic Private sectors. It is thus at least possible to exploit geographic variation in SOE intensity to ascertain its effect on the domestic private sector. Simple regressions using 2012 and 2016 data are reported in Figure 17. These show that provinces with stronger SOE presence - proxied for by employees in the SOE sector - experienced smaller domestic private sector employment growth and firm size growth between 2012 and 2016. This indicates, in effect, that SOEs suppress both formal private sector employment and private sector firm size - which are conventionally seen as key inputs to productivity.

Figure 17. Regressions Concerning the Impact of SOEs on Domestic Private Growth. (Source: General Statistics Office of Vietnam)

Dependent Variable: 2016 Non-SOE Employment	
2012 Non-SOE Employment	1.2992***
	(0.028)
2012 SOE Employment	-0.3101**
	(0.152)
Constant	13720**
	(5969)

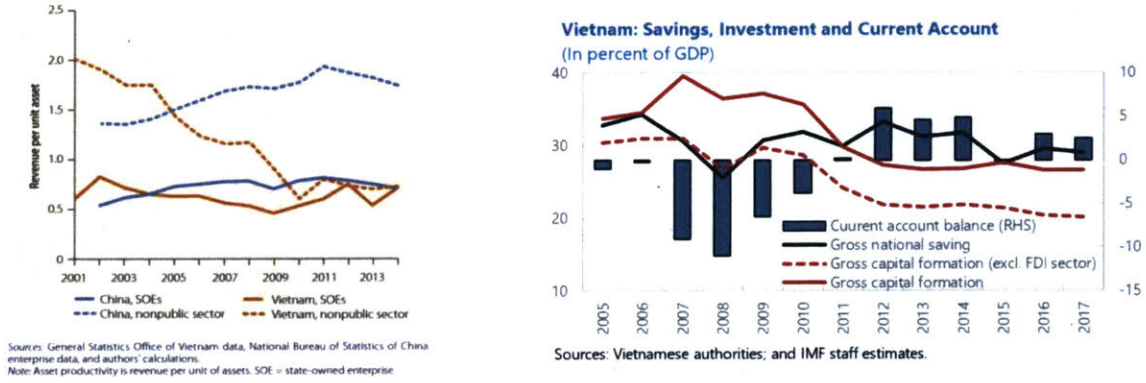
Dependent Variable: % Growth in Domestic Private Firm Size, 2012 - 2016	
% of Employment from SOEs, 2012	-0.6169***
	(0.216)
Constant	-0.0577
	(0.045)

These results closely match an earlier finding in the literature, indicating an ongoing problem. Van and Freeman (2009) assess the relationship between SOEs and the private sector in the early 2000s, finding that provinces with greater SOE density experience worse growth in private sector employment, private sector firm count, and GDP per capita. They leverage survey results to investigate the causal channels for these deleterious effects, finding that SOEs crowd out access to critical resources such as land and bank loans. Since SOEs enjoy preferential access to these resources - in earlier times due to formal regulation and today due to informal political connections and practices - it is hardly surprising that there is a limited amount left for the rest of the domestic economy. The authors note, for instance, how 95% of land allocated for domestic business activities in Hanoi in 2002 was occupied by SOEs. A more recent 2015 World Bank assessment of SOEs in Vietnam finds they enjoy decisively preferential access to financing and are able to dominate markets unfairly due to subsidies and absent concerns of

bankruptcy[8]. The fact that the FDI sector is far more productive than the domestic economy and receives a separate allocation of resources through Special Economic Zones (SEZs) in which it does not compete with SOEs is highly suggestive that this differential is critical.

As if these effects were not bad enough, there are additional consequences which may further reduce the competitiveness of the domestic private sector and imbalance the wider economy. Asset productivity in the domestic private sector has been falling over time - plausibly because, in the absence of fair competition, good initial opportunities following liberalization are being exhausted - and, in tandem, non-FDI investment has fallen too (Figure 18). Vietnamese citizens cannot be faulted for electing to invest little when a major investment outlet, private business formation, yields such terrible dividends. This disincentive contributes to an excess of savings over investment and thus an overheating economy, which elevates wages and thus makes private business expansion even less attractive.

Figure 18. Falling Domestic Asset Productivity and Investment. (Source: General Statistics Office of Vietnam, IMF)



The unlevel playing field enjoyed by SOEs seems to be a major reason why Vietnam's domestic private sector remains fragmented and barely profitable. SOEs consume critical resources allocated to the domestic economy and in some cases have explicit subsidies and monopolies, all of which prevents

8 http://www.economica.vn/Portals/0/Documents/SOE%20Evidences%20of%20Preferential%20Treatments%20ENG%20Final.pdf

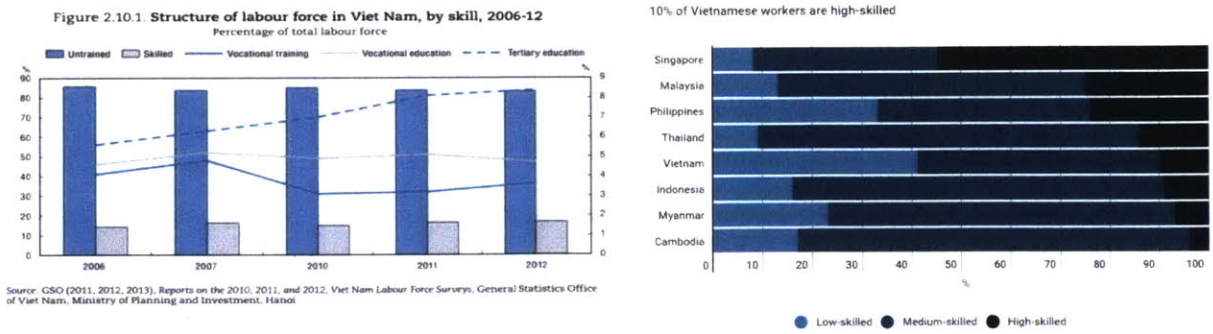
private domestic firm entry and growth. **The rules of competition governing SOEs are thus a binding constraint to the productivity of the domestic private sector.**

Human Capital

The cursory examination of Vietnam's education enrollment rates presented in Figure 8 is, it turns out, highly suggestive of the state of human capital in the country. Lower-level education and skills are indeed well-supplied. Primary and secondary enrollment rates are 98% and 93% respectively, while secondary transition rates are 99%. The literacy rate of people aged 15-24 years was 98% in 2015 and mean years of schooling, which stood at 8.2 as of 2017, have sharply increased since the 1990s. Vietnam's position in the Penn World Tables' Human Capital Index increased between 2012 and 2017 and is higher than average for both its regional and income level.

Undoubtedly this excellent supply of basic skills has supported Vietnam's ascent as a low-cost manufacturing destination. Concern is warranted, however, that Vietnam's skill profile is *too* basic and that it is in short supply of higher-level skills. Recall from Figure 8 that the country lags on tertiary enrolment. The International Labor Organization also deems Vietnam to have the highest share of jobs at a high risk of displacement from automation in Southeast Asia, which in practice - their analysis is based on the O*NET analysis of Frey and Osborne (2013) - means that an alarming 70% of Vietnamese jobs constitute a series of repetitive manual tasks. Ominously, the Vietnamese skilled workforce has failed to grow for more than a decade (Figure 21). How, one might ask, is Vietnam to move up the economic value chain if 70% of its workforce are stuck in careers which do not require critical thought?

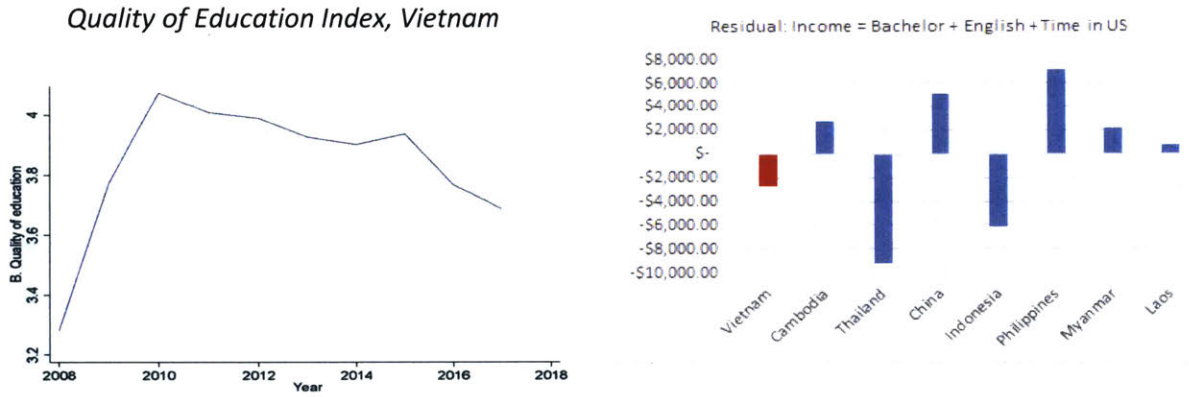
Figure 21. High-Level Skills in Vietnam vs. Peers. (Source: General Statistics Office of Vietnam)



Even when Vietnamese invest in higher education the high-level skills they receive tend to be low-quality. Vietnam's Quality of Education Index has been declining in recent years (Figure 22) and the country's pupil-teacher ratio is the worst in the world at the tertiary level. There is evidence,

furthermore, that first-generation Vietnamese immigrants in the US experience lower returns to education than peer immigrants (Figure 22). Taking each Asian immigrant group as an observation and regressing average household income on the proportion of the group with a bachelor's degree, with high English proficiency, and with more than ten years spent in the US Vietnam is below the trendline, whereas most countries are above. Given that measures of English proficiency and time spent in the US are quite objective and that a number of covariates such as culture and susceptibility to discrimination are common to the ethnic groups in question the best explanation for the omitted variable bias that produces Vietnam's negative residual is low-quality higher education.

Figure 22. Low Quality of Vietnamese Tertiary Education. (Source: Penn World Tables, Pew Social Trends)



Critically, advanced skills in Vietnam are not just underdeveloped and hard to come by; they command a high price, specifically in the foreign-owned, export-oriented economy. Although just 7.4% of domestic firms cite an inadequately educated workforce as a major constraint in Vietnam's 2015 World Enterprise Survey, a whopping 28.2% of foreign firms do so - nearly triple the rate for their next-most commonly identified constraint (Figure 23). This seems to be attributable both to a skill shortage and skill gap; that is, employers complain that their openings for skilled positions receive an insufficient number of applicants, and the applicants they do receive are not sufficiently skilled for the position (Figure 23). Employers, local and international, hold education system accountable for not equipping graduates with requisite skills needed, noting the skill gap to be the highest for technical, professional and managerial positions. When firms do manage to find skilled hires, they pay high wages to keep them compared to other Asian economies. Indeed, returns to tertiary education in Vietnam are 50% versus 12.6% in East Asian peers (Figure 24). This lack of skilled labor seems to be slowing down Vietnam's economic transition from labor-intensive industries to high-tech goods.

Both employers and students compensate for insufficient higher education at home in a "Hippos in the Sahara" phenomenon. The former are investing more and more in on-the-job training and some surveys indicate extraordinary wage premiums for skilled expatriates in Vietnam (Figure 25). While it doesn't draw a random sample, HSBC's Expat Explorer Survey finds that expats in Vietnam earn the second-most in Southeast Asia at $103,000 on average, behind only Singapore. This is fifty times more than the earnings of an average Vietnamese citizen and ten times more than the average in Vietnam's highest income bracket. Vietnamese students, meanwhile, have the fastest-growing outward mobility to foreign universities among peer countries and have the 9th highest number of students abroad in the world.

Figure 23. Employer Identification of Skill Shortages and Gaps as a Business Constraint. (Source: World Enterprise Survey)

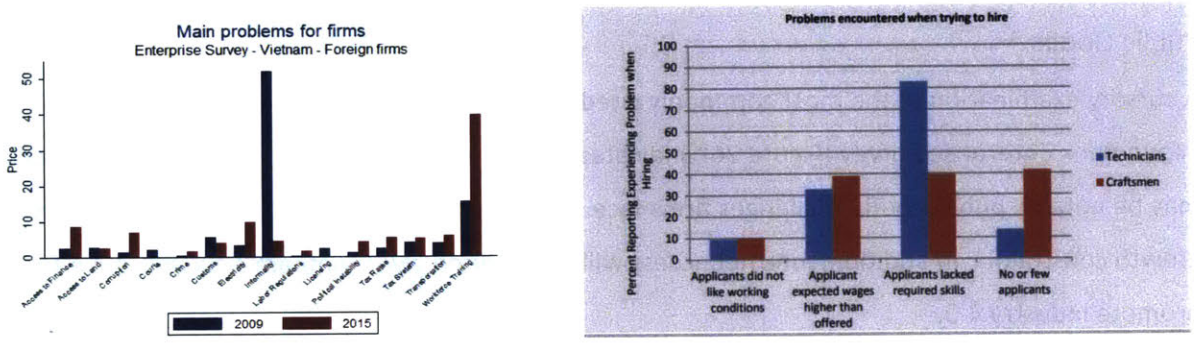
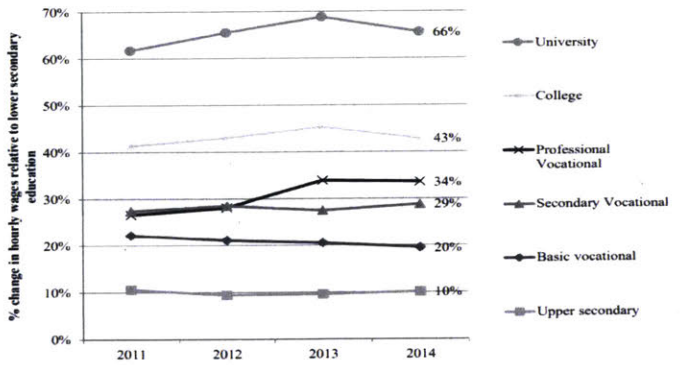


Figure 24. Returns to Education in Vietnam. (Source: General Statistics Office of Vietnam)

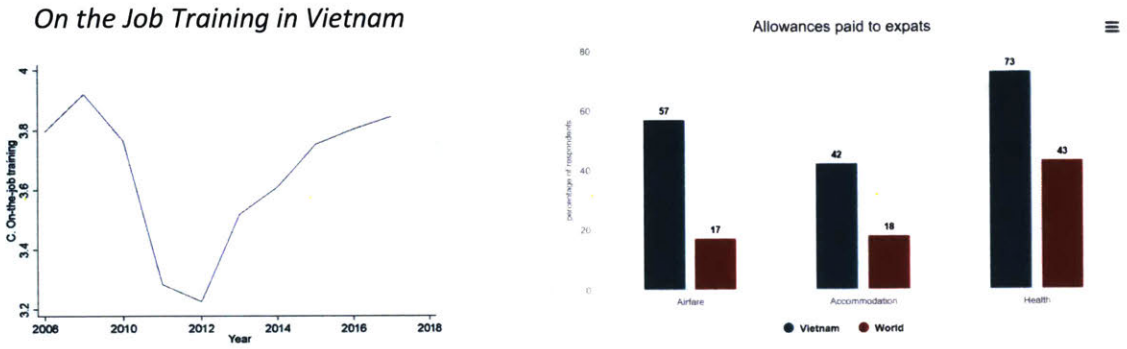


Source: Analysis of 2011- 2014 Labor Force Surveys
Note: The reported coefficients are calculated from (hourly) log wage (including bonues) regressions restricted to all wage workers which control for a cubic in age, urban/rural, region, gender, and ethnic minority status.

It appears, as such, that foreign investors in Vietnam are burning to move into higher-complexity exports but encounter substantial difficulty doing so due to insufficient availability of high-level skills. Vietnam's export sector is the key to its economic vibrancy and progress, and it cannot afford to neglect

such an outstanding barrier to its productivity. **Insufficient high-level skills are thus a binding constraint to productivity in Vietnam's foreign-, export-oriented sector.**

Figure 25. Employer Compensation for Insufficient Access to High-Level Skills. (Source: World Economic Forum, Expat Explorer Survey)



Public Goods

A cursory examination of the most commonly cited business constraints in Vietnam, reported in the World Bank Enterprise Survey (Figure 26), indicates that corruption, customs, transportation, electricity may be notable public goods challenges firms face. Those public goods will all be diagnosed as potential growth constraints; in addition, internet access will be analyzed given Vietnam's current drive to promote Industry 4.0.

First, price-quantity graphs are produced (Figures 27-31). Indicators of internet price, being unavailable in the Enterprise Surveys, are obtained from a 2017 study by cable.co.uk. Among the public goods in question, the most compelling cases for the presence of growth constraints (as shown via relatively high prices) are corruption, transportation, and electricity access. While firms of all varieties appear to consider corruption a problem more often than peers in comparable countries, foreign firms appear to be particularly sensitive to the issue. Given that these firms are in the best position to compare Vietnamese conditions internationally their stance is telling. Transportation, conversely, appears to be the biggest problem for small domestic firms (as the aggregate indicator is higher than for large, foreign, or exporting firms). Adding even more nuance, electricity is of concern to exporting and foreign firms, where it registers highly compared to peers, but appears to worry few average Vietnamese firms. This indicates that the internationally-oriented part of Vietnam's economy may be more constrained by electricity, whereas its domestic component is more constrained by transportation. Interestingly, despite slow internet speeds low data prices indicate that internet is not a constraining factor for

Vietnam's growth. Given their finite budgets Vietnamese policymakers may thus want to exercise caution in emphasizing digital infrastructure to accelerate Industry 4.0 adoption, at least for the time being, as other areas of the economy may warrant more attention.

Figure 26. Growth Constraints Cited by Firms in Vietnam. (Source: World Enterprise Survey)

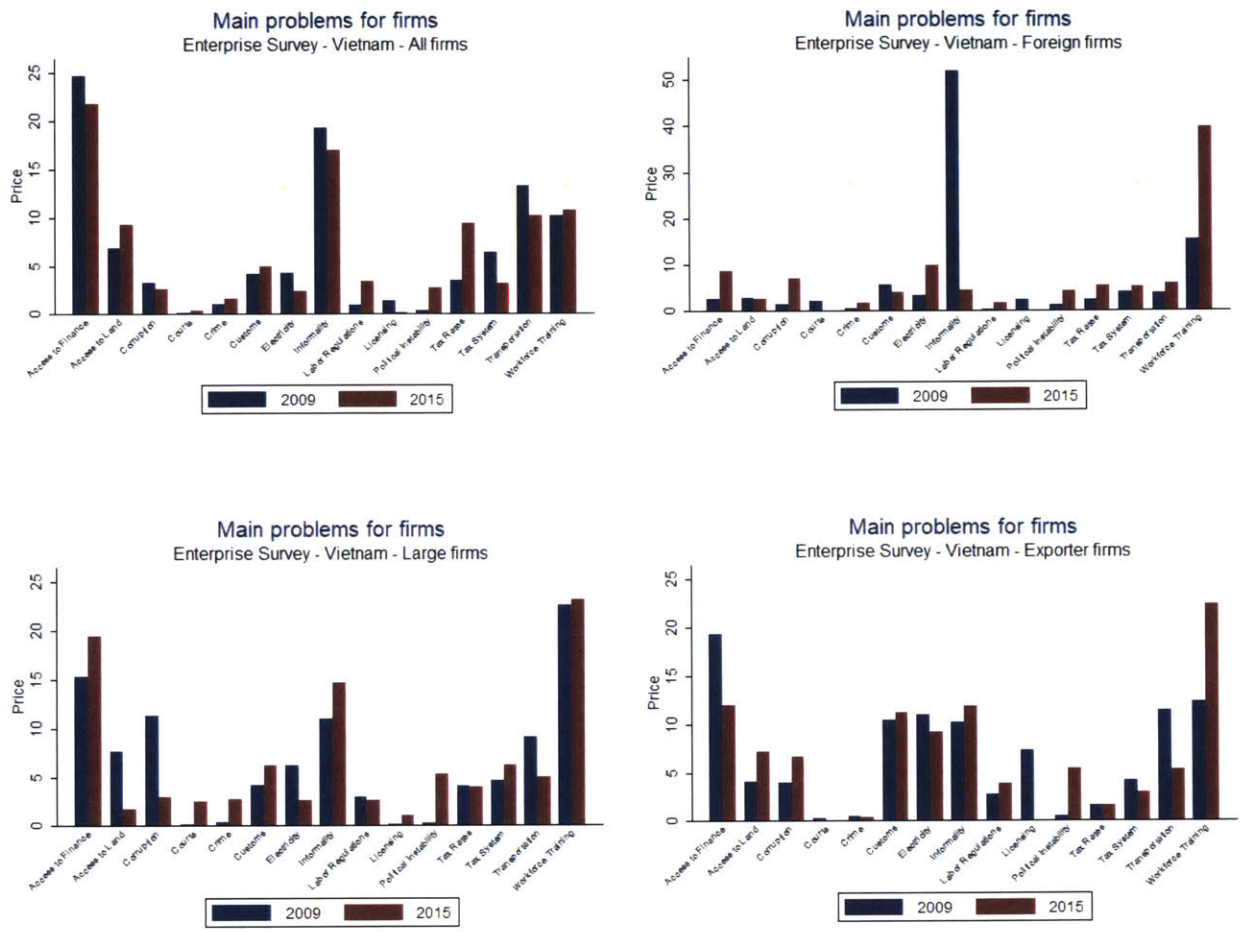
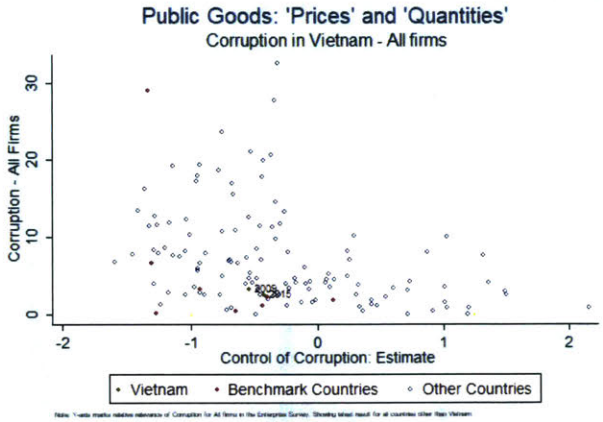
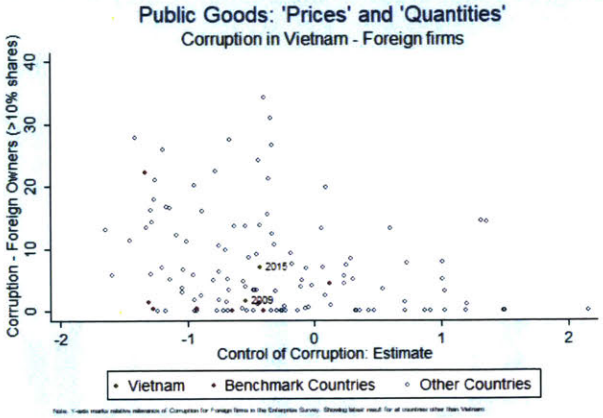
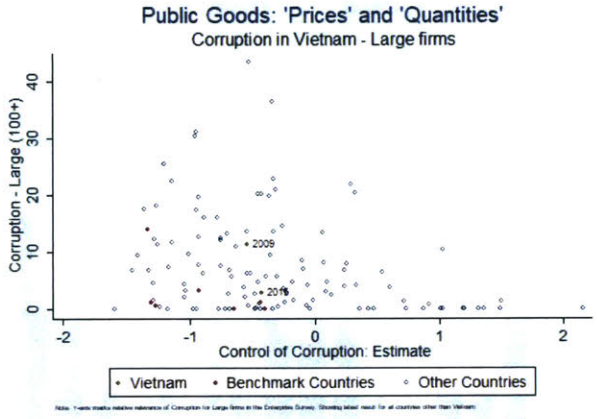


Figure 27. Citation of Corruption as Main Business Constraint by Firm Type. (Source: World Enterprise Survey)







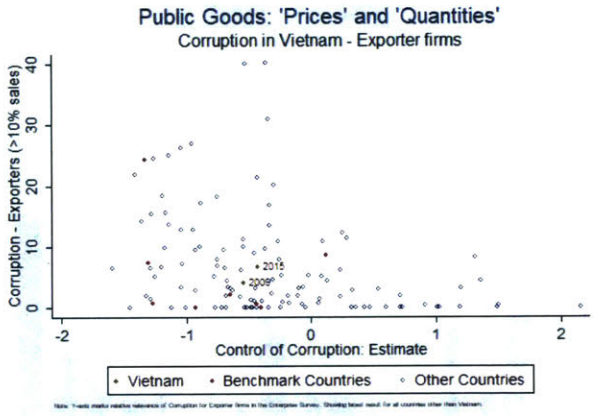


Figure 28. Citation of Customs as Main Business Constraint by Firm Type. (Source: World Enterprise Survey)

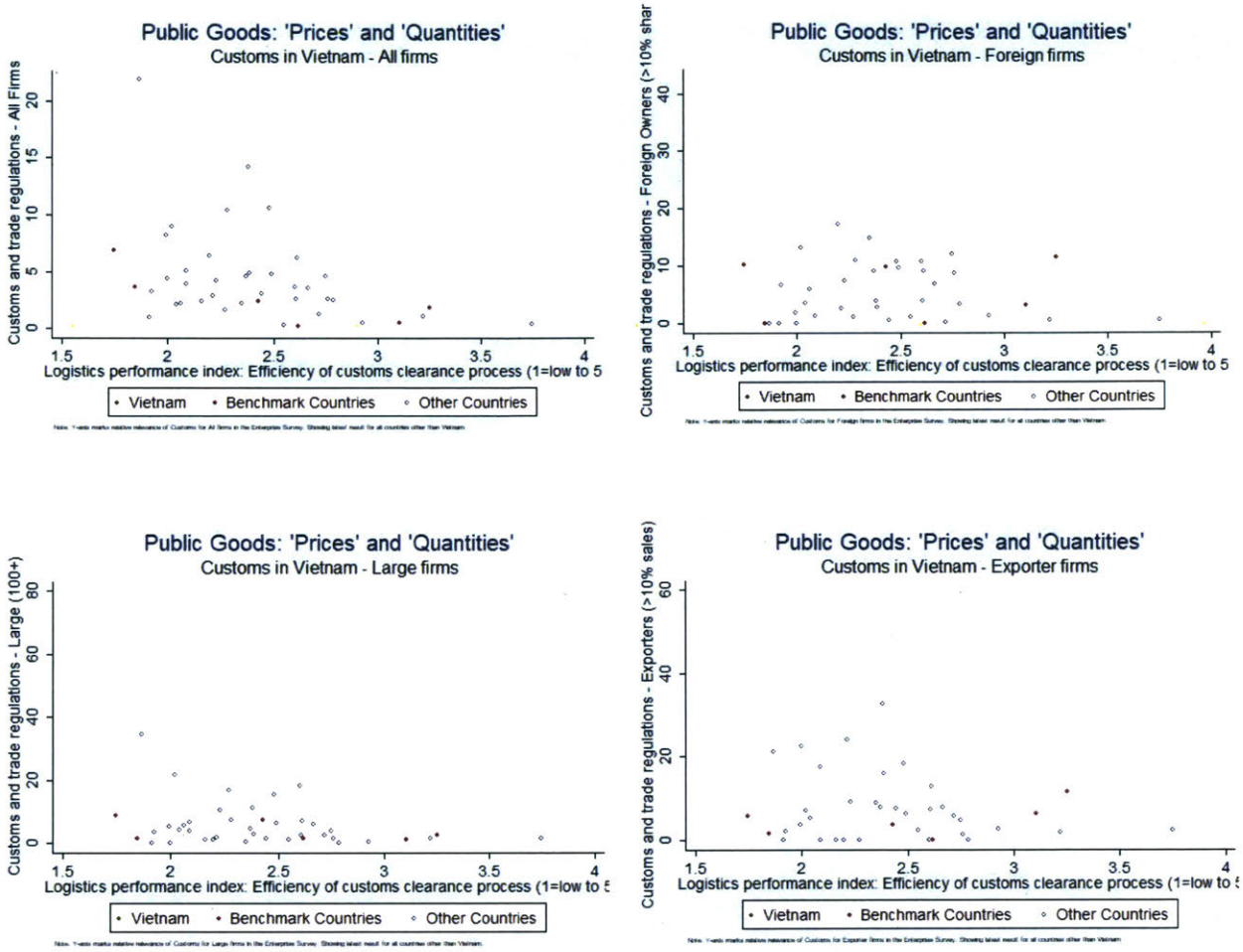


Figure 29. Citation of Electricity as Main Business Constraint by Firm Type. (Source: World Enterprise Survey)

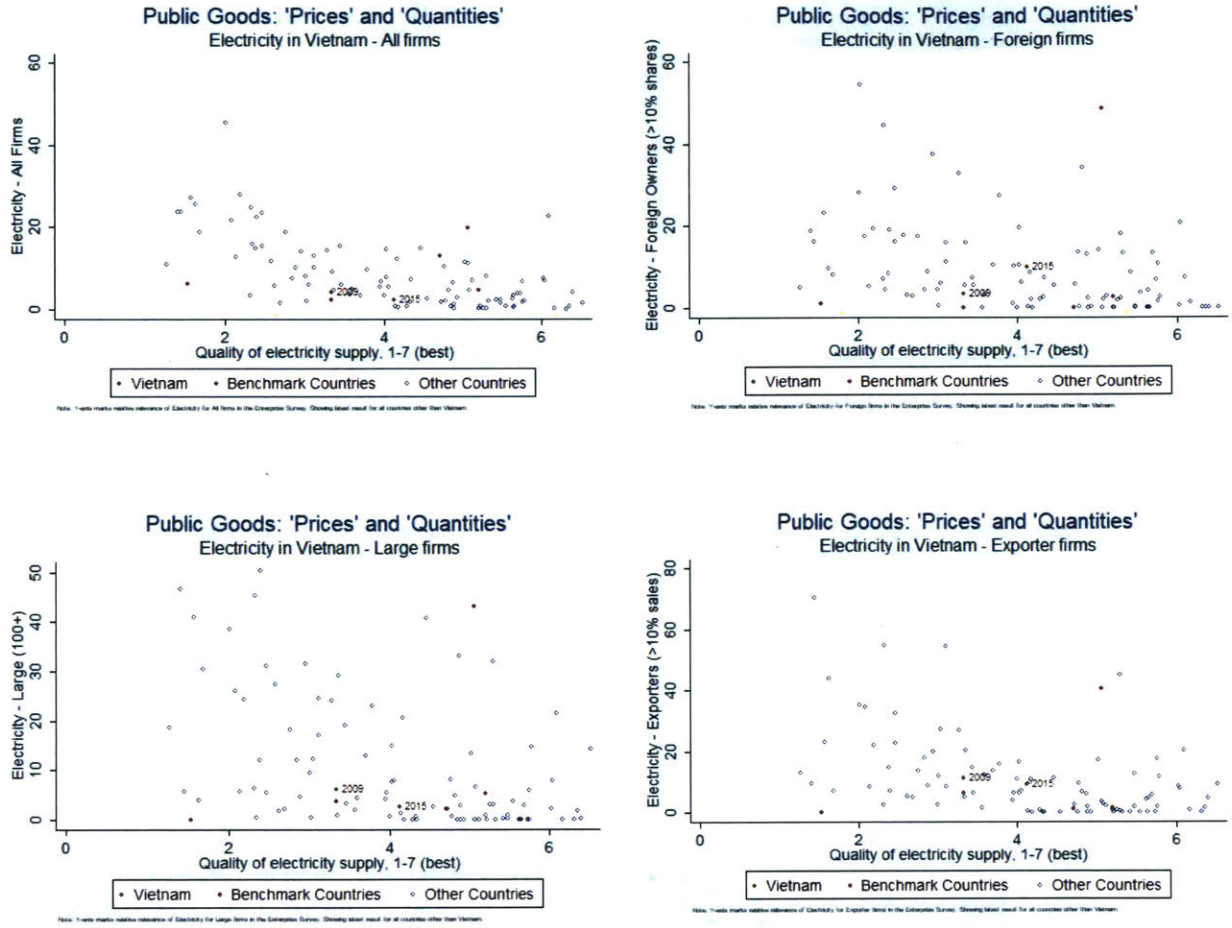


Figure 30. Citation of Transportation as Main Business Constraint by Firm Type. (Source: World Enterprise Survey)

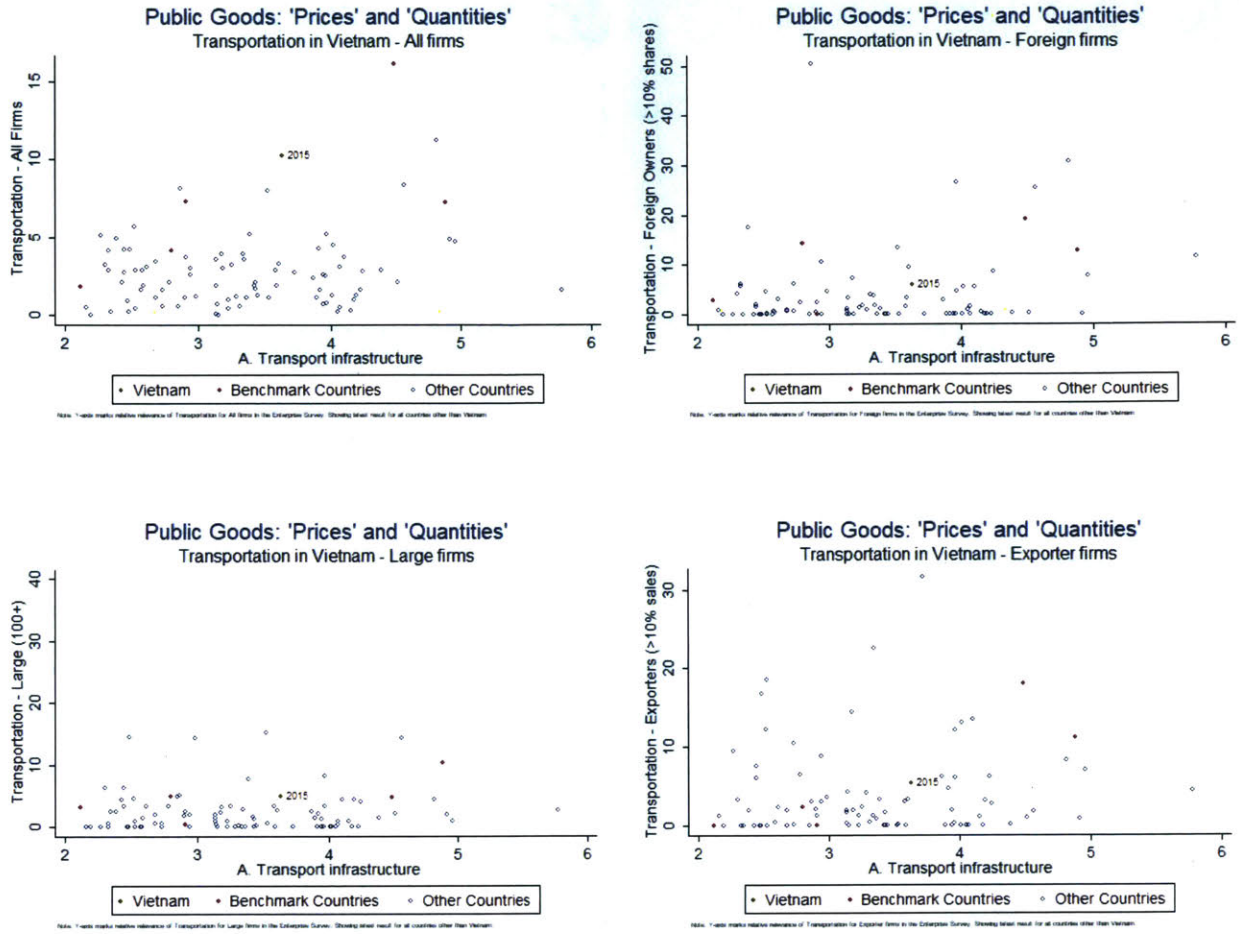
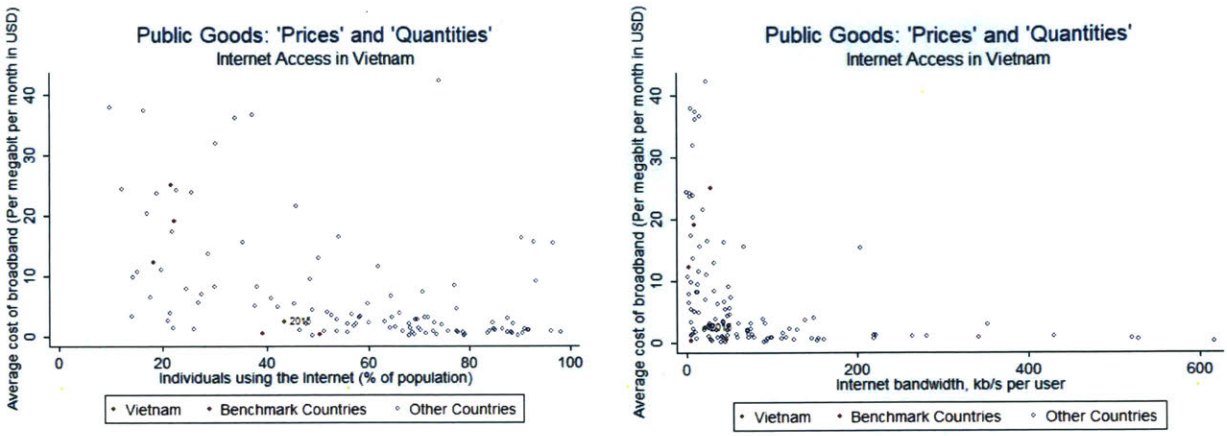
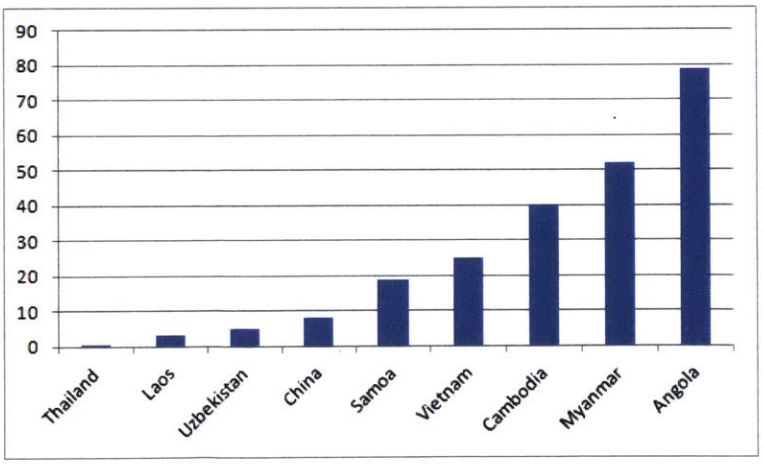


Figure 31. Price of Internet vs. Quantity Supplied, Extrema Truncated[9](Source: World Enterprise Survey)



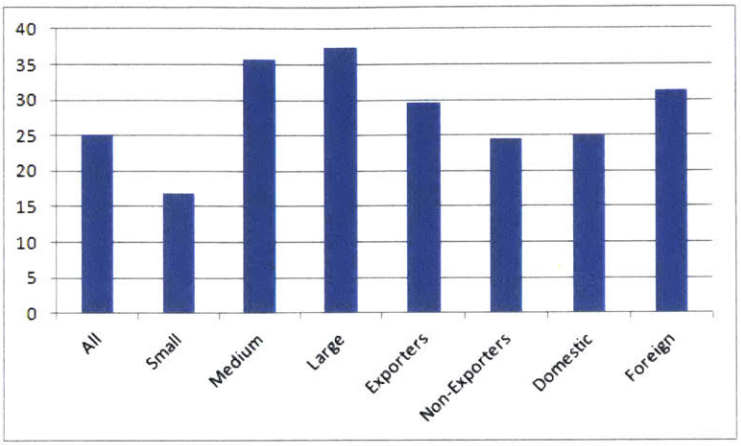
The availability of data on generator ownership from the Enterprise Survey next allows us to investigate the possibility of a "hippos in the desert" phenomenon for electricity (Figures 32 & 33). Compared to nine peer countries Vietnam is in the upper half of generator usage, while large, exporting, and foreign firms report owning generators most commonly. This reinforces the previous supposition that electricity may be a sensitive issue for internationally-oriented firms such as power-hungry manufacturers. Given that Vietnam reported a 100% electricity access rate in 2016 while Figure 29 shows it has middling electricity quality, such firms likely purchase generators to overcome issues related to power supply interruptions.

Figure 32. Percent of Firms Owning/Sharing a Generator by Country. (Source: World Enterprise Survey)



[9] Data Source: https://www.cable.co.uk/broadband/deals/worldwide-price-comparison/

Figure 33. Percentage of Vietnamese Firms Owning/Sharing a Generator by Category. (Source: World Enterprise Survey)



Finally, "camels vs. hippos" phenomena are investigated in the international sector by determining the extent to which the distribution of Vietnamese exports have been sensitive to infrastructure constraints from 1995 to 2015 (Figure 34). The intensivity of different industries in various infrastructure inputs in a relatively frictionless environment is obtained from the U.S. Bureau of Economic Analysis (BEA), and exports for different countries are aggregated from the HS 4-digit level to the coding used by the BEA. The following specification is then used to obtain each country's specialization towards or away from a given input in a particular year:

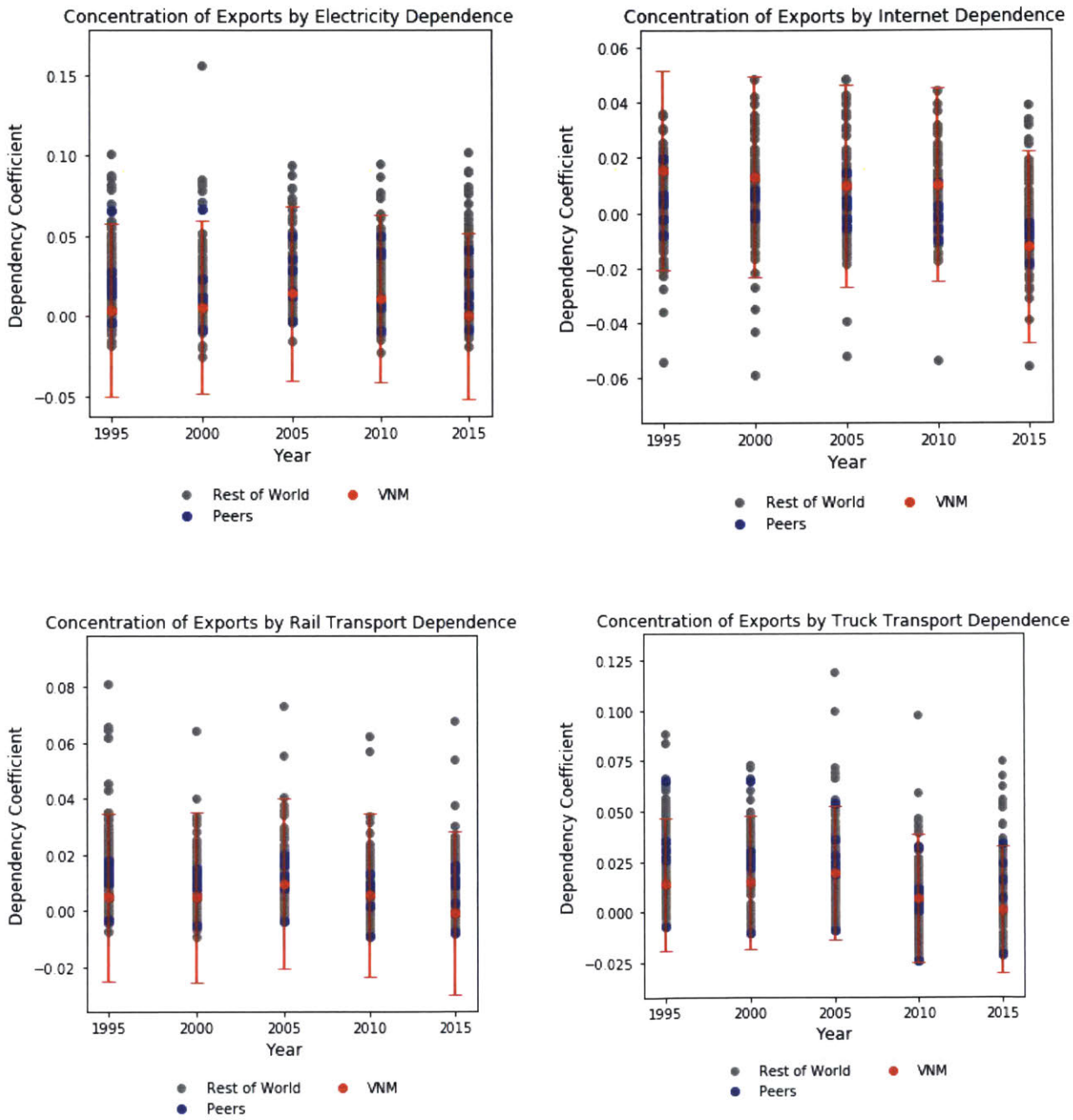
$$y_{c,i} = \beta_0 + \sum_{\forall c} \beta_c D_c INT_{i,c} + D_c + D_i + \varepsilon_{c,i}$$

Where the outcome variable is the share of exports country c has in industry i, INT is the intensivity of an industry i in an infrastructure input, and each D is a dummy variable corresponding to its subscript[10].While Vietnam has a middling position relative to the world distribution and peers for internet and truck transport it is near the bottom of the distribution in electricity and rail transport in particular. As such there is mixed evidence on transport as a whole, but reasonable evidence that

[10] For more information see: https://github.com/eric-protzer/dependency-dev309

Vietnamese exports partly specialize away from power-intensive sectors. This further indicates that electricity quality may be a problem for exports, but not transportation nor internet.

Figure 34. Specialization of Vietnamese Exports in Infrastructure by Type. (Source: Harvard Atlas of Economic Complexity, US Bureau of Economic Analysis)



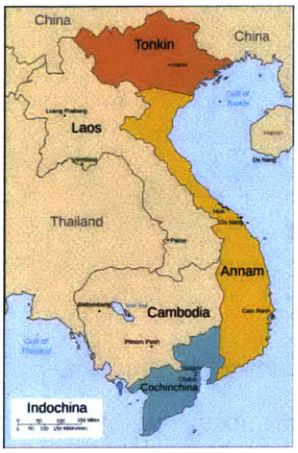
On balance it appears that poor electricity quality is problematic for the foreign-, export-oriented sector of the Vietnamese economy. However, its shadow prices and rates of generator ownership are not

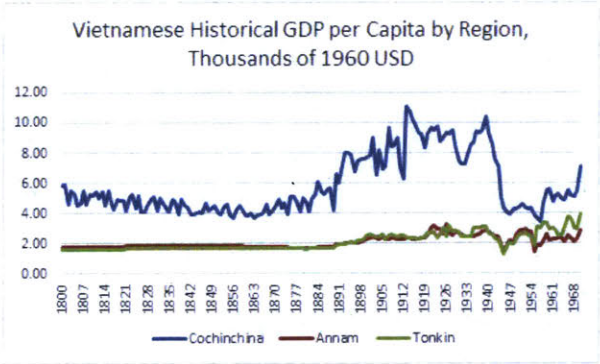
terribly extreme; average reported sales losses due to power blackouts are only 2.2%; and investment continues to pour into Vietnam's manufacturing sector. Other infrastructure problems seem less severe, and corruption, while never a good thing, is cited less often than other problems. **I thus do not identify infrastructure nor corruption as binding constraints for Vietnam, but note that measures to improve the power supply and reduce corruption would help to prevent these from becoming more serious issues in the future.**

Urban Development

Vietnam has a long history of uneven regional growth which continues to affect it today. Under French colonial rule Vietnam was divided into three territories: Cochinchina in the south, Tonkin in the north, and Annam in between. Cochinchina was historically the most densely-populated and wealthy, whereas Annam and Tonkin were relative backwaters (Figure 35). Today the area occupied by Cochinchina is still the richest part of Vietnam, while industrialization around Hanoi has also boosted urban incomes in the north (Figure 9).

Figure 35. Historical Distribution of Wealth in Vietnam (Source: Bassino 2001)





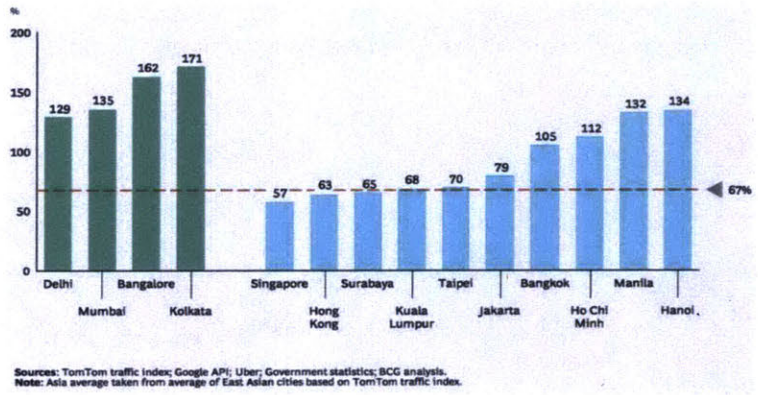
Despite the higher incomes persistently (and especially now) offered in urban centers, 65% of the Vietnamese population remains rural and 40% is employed in agriculture (Figures 2 & 9). Just 14% of Vietnamese were internal migrants in 2015[11]; by comparison 20% of Chinese were. As such Vietnamese

11 https://bangkok.unesco.org/sites/default/files/assets/article/Social%20and%20Human%20Sciences/publications/vietnam.pdf

structural transformation is incomplete and proceeding somewhat slowly. Reallocating 90% of the agricultural workforce to the manufacturing sector would, holding sectoral productivities constant, boost GDP by up to 35%. This would not only materially improve the living conditions of Vietnamese citizens, but provide more breathing room for Vietnam to implement serious reforms.

Some barriers to accelerate urbanization are economic while others are political. One issue is that cities are simply relatively full, and more infrastructure is needed to effectively integrate newcomers. An indicator of this issue is Vietnam's urban congestion, which ranks among the worst in Asia (Figure 36). In addition, however, Vietnamese citizens live under a restrictive residency system known as Ho Khau (analogous to China's better-known Hu Kou system)[12]. While it is not enforced as strictly as in the past, the Ho Khau system makes it more difficult for internal migrants to access government services like subsidized electricity and water, reduced-rate rent, education for children, and public insurance. As a result, 30% of internal migrants consider their housing situation to be worse than in their location of origin.

Figure 36. Road Congestion in Peak Hours Across Asian Cities, 2017 (Source: Boston Consulting Group)



While urbanizing Vietnam's rural population would improve the country's productivity by moving them into the manufacturing and services sectors, these sorts of gains are mostly one-off. If I found that productivity growth was a non-issue in cities but a major problem in rural areas urbanization would be a binding constraint, but this does not appear to be the case. Recall, indeed, that even champion industries at the forefront of the Vietnamese economy have experienced anemic productivity growth. **As such insufficient urbanization is not a binding constraint to productivity growth. However,**

[12] Idem.

accelerating urbanization to complete Vietnam's structural transformation would provide one-off gains to GDP and thus could buy more time for other reforms.

Finance

At first blush, access to finance in Vietnam appears to be a possible problem. Vietnamese firms identified access to finance as their largest business obstacle in 2015, and identified finance as an issue at the highest rate among peers in 2009 (Figures 37, 38); thus, the shadow price is high. At the same time, however, real interest rates have been low for the region (Figure 39) and domestic credit to the private sector has dramatically improved over the course of the 2000s, with Vietnam now standing among the best-performing countries in the region (Figure 40). Vietnam also scores best among peers for getting credit (Figure 38). Given the massive amount of investment that has flowed into Vietnam this is not surprising. A conundrum thus presents itself: if financing is relatively plentiful and cheap, why do firms maintain it's an issue?

Figure 37. Ranking of Top Business Environment Obstacles for Firms (Source: World Enterprise Survey)

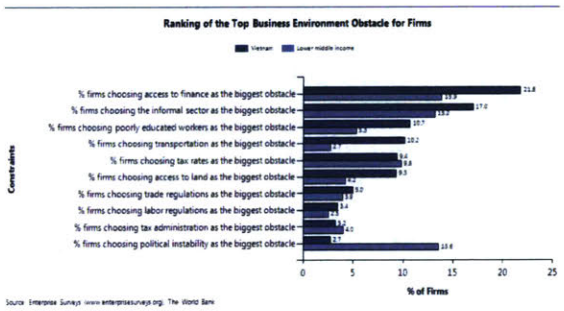


Figure 38. Shadow Price of Finance vs. Peers. (Source: World Enterprise Survey)

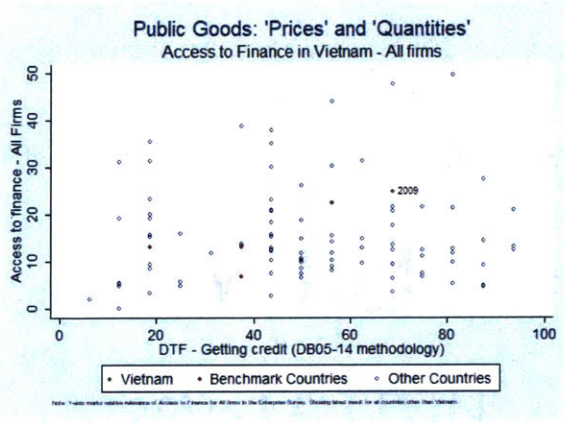


Figure 39. Real Interest Rate vs. Peers (Source: World Bank)

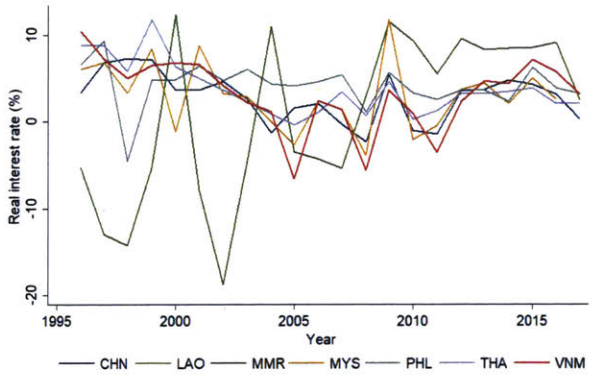
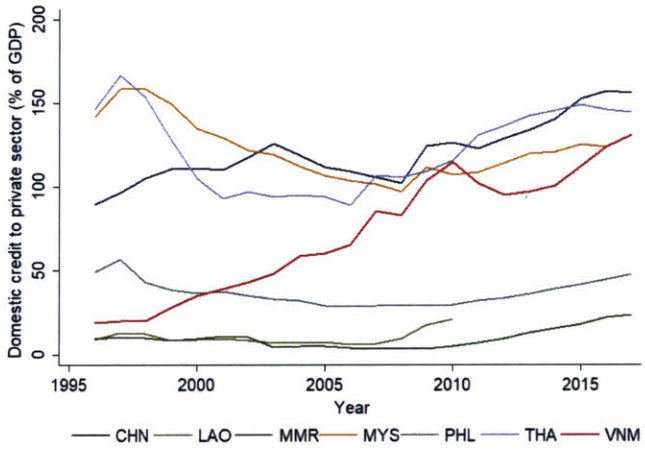


Figure 40. Domestic Credit to Private Sector % of GDP vs. Peers (Source: World Bank)



A clue comes from Vietnam's low bank deposit to GDP ratio (Figure 41). While finance nominally appears to be well-supplied, it appears that firm participation in finance is low. We would expect foreign-owned firms in the export sector to store their cash outside of Vietnam, while SOEs operate through government budgets; but the domestic private sector should still store its savings in domestic banks. Vietnam's persistently low bank deposit rate indicates they do not, which we can confirm with more data from the World Enterprise Survey (Figure 42). The proportion of Vietnamese firms with a bank account is substantially below world and East Asian averages.

Figure 41. Bank Deposits to GDP vs Peers (Source: World Bank)

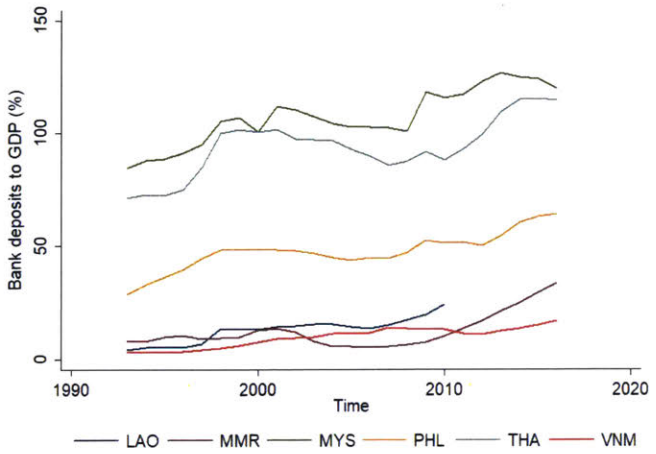
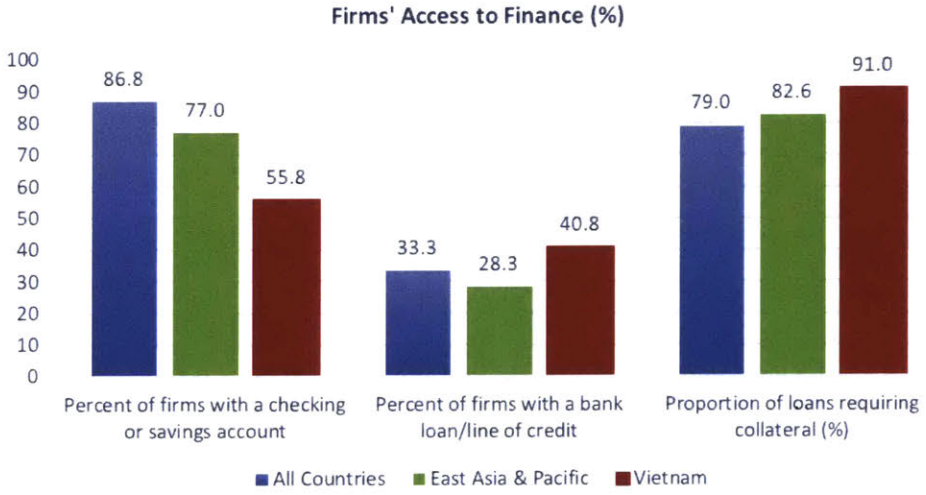
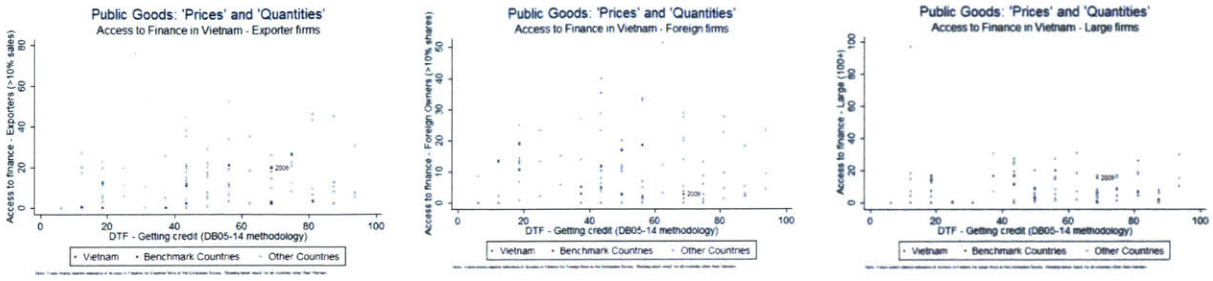


Figure 42. Access to Finance vs. Peers (Source: World Enterprise Survey)



This suggests that financing in Vietnam is the biggest problem for the domestic private sector, which despite what should be an abundance of credit cannot access it. Further support from this notion comes from decomposing the shadow price by firm type (Figure 43): exporting, large, and especially foreign firms complain about access to finance at a lower rate than average. While a breakdown for firms that are both domestically owned and small to medium-sized – in other words, from the domestic private sector – is unfortunately not available, this implicitly indicates those types of firms are responsible for the high overall rate of complaint about finance.

Figure 43. Access to Finance in Vietnam by Firm Type. (Source: World Enterprise Survey)



There are two possible explanations why the private domestic sector is unable to access credit in Vietnam. One is that banks do not like to give loans to such firms because their returns on assets (Figure 16) are so low. The other, which is not mutually exclusive, is that arbitrary rules prevent this sector from accessing credit. A common anecdotal complaint in Vietnam is that collateral requirements for loans are too high, and indeed the proportion of loans in Vietnam requiring collateral is higher than the world and regional averages (Figure 41). However, it is not much higher. A more plausible explanation is that access to finance is crowded out by State-Owned Enterprises (refer to that section). In either the former or latter situation, however, the problem is not an underdeveloped financial sector per se, but some other aspect of the economy interacting with finance. **Given that an underdeveloped financial sector does not appear to be a problem for Vietnam it is not a binding constraint; nevertheless, attention is merited to interacting factors such as rules governing State-Owned Enterprises which prevent the domestic private sector from accessing finance.**

Summary of Key Constraints

Based on the analysis of potential constraints above, the binding constraints and non-constraints are identified in Table 3 and elaborated thereafter.

Table 3. List of Constraints

Binding Constraints	Non-Constraints
• State-Owned Enterprises • Human Capital	• Finance • Public Goods • Urbanization

- State-Owned Enterprises stymie growth in the domestic private sector. They are granted monopolies, subsidies, and preferential access to critical resources like land and financing; this crowds out resources for private companies and denies them a level playing field in the competition for customers. **Rules of competition governing State-Owned Enterprises are thus a binding constraint to productivity growth in Vietnam.**
- A deficit of high-level skills prevents the foreign-owned, export-oriented sector from moving into the production of more complex goods. Well-educated employees are scarce; the quality of the education they receive tends to be poor; foreign companies cite an inadequately educated workforce as by far their largest barrier to growth; and skill premiums for both expats and well-educated Vietnamese are very high.
- Some public goods like control of corruption, electricity quality, and transportation infrastructure are known issues in the economy but are not significant growth constraints. Shadow prices and adverse impacts are non-zero, but are not immensely high. For example, while generator ownership in Vietnam is higher than in some peers the average company attributes annual sales losses of only 2.2% to blackouts.
- Higher urbanization rates could provide one-off productivity gains which would give Vietnam more breathing space to address other issues, but **there is no evidence that productivity growth is only a serious problem in rural areas.** Indeed, even Vietnam's highly urban champion industries exhibit poor productivity growth.
- The domestic private sector has difficulty accessing finance, but this appears to be due to crowding out from SOEs rather than an underdeveloped financial sector. State-Owned Enterprises retain preferential access to finance and returns on assets are very low for the private domestic sector, which further disincentivizes banks from lending to them. Vietnam does not so much need to develop its financial sector as ensure fair access to it.

IV. Syndrome: The Overbearing State

Since embarking upon Doi Moi reform in the 1980s, the Communist Party of Vietnam has allowed a modicum of openness which has proven essential to export-driven capital accumulation. The clock is ticking, however, for Vietnam to reform itself in order to innovate past the middle income trap and the looming threat of automation. To avoid these threats it desperately needs to improve its productivity growth.

Policymakers will undoubtedly be tempted to leap to the technological frontier by installing high-end internet infrastructure and training legions of programmers. As this growth diagnosis proves, however, the critical blockages on Vietnam's technological progress are far more foundational. Its domestic private sector maintains a small average firm size and commensurately low productivity because critical resources like financing and land are massively diverted towards inefficient SOEs. Due to their preferential access SOEs consume a full 49% of investment in Vietnam, yet they provide a fraction of employment and a majority are loss-making. The need to reform and divest SOEs has long been recognized, but in practice has been slow to proceed due to vested interests. Plans to privatize SOEs have been repeatedly delayed, and though the government has announced it will divest 406 SOEs by 2020 several thousand exist.

The export sector, thus far the engine of dynamism in Vietnam, is hampered by insufficient access to skilled personnel. The Vietnamese higher education system is deeply influenced by Confucian and communist ideology, with admission criteria to curriculum design centrally overseen by the Ministry of Education and Training. A full 12% of the average university student's coursework is in Marxism and Ho Chi Minh thought, while rote learning is emphasized above critical thinking. As a result foreign investors pay huge premiums for expats and the few Vietnamese citizens who have advanced skills.

The overbearing Communist Party uses SOEs and a centralized, ideological education system to maintain political control over Vietnam. In their eyes there are real risks associated with a powerful domestic private sector and a well-educated, free-thinking citizenry. The legitimacy of the Communist Party, however, also derives substantially from delivering economic growth. Continual political opening will be necessary to create the technological change required for prosperity, and there is thus a strong, albeit tortuous, incentive to reform SOEs and modernize the education system.

V. Policy Prescriptions

As per the above findings, policy recommendations for Vietnam are organized broadly into factors relating to Skill Development and those relating to State-Owned Enterprises. Although the most critical reforms for the Vietnamese economy may be politically difficult, in the medium term they may prove necessary for the Communist Party to implement in order to maintain legitimacy from economic growth.

Skill Development

Modernizing Vietnam's higher education system will require the government to relinquish full centralized control over the way universities are run in line with international norms. Existing universities must feel free to set a substantial portion of their own agendas, while the establishment of new, private institutions of higher learning should also be permitted. This will allow universities to better respond to the educational goals demanded by students and industry instead of the Communist Party. Encouraging international cooperation with foreign universities may go further towards improving the quality of advanced education through the transfer of tacit knowledge. Funding, additionally, ought to be diverted from wasteful ideological indoctrination towards work-relevant programmes covering technical skills, English, and commerce.

A strong role for the Ministry of Education and Training could nevertheless remain in coordinating between industry and higher education on a national level. The government is well-positioned to gather information on the most-demanded skills from critical industries, which universities would then be able to compete to provide. Direct industry-university cooperation such as apprenticeship programs could be encouraged, and vocational colleges with precisely targeted programs could be funded.

SOE Reform

While politically difficult to absolve in one measure, SOEs can conceivably be reduced in importance over time. As a transitionary phase it may be politically palatable to create Public-Private Partnerships in strategic industries such as energy and transportation. A profit motive would be introduced while the government would be able to retain oversight over critical decisions, and may thus feel comfortable with the arrangement. These entities would not only help rationalize the sectors in question, but would go a long way towards politically normalizing a significant private presence in the domestic economy.

Ultimately, reform must of course go much further. SOEs and domestic private firms need to be put on a level playing field by discarding explicit supports for the former and legislating equal rights for the latter. The monopolies, subsidies, and regulatory limits to private ownership that allow SOEs to dominate must be ended, while domestic private firms need to be given fair access to resources. For instance, private ownership of land is not permitted in Vietnam. SOEs consequently dominate commercial land outside of SEZs, and only lease to domestic private firms at high prices. This absurd barrier to private sector growth is obviously rectified by allowing private ownership of land. Critically, reforms concerning fair market competition are far more important than the mere privatization of SOEs. While divesting SOEs may help rationalize parts of the economy, remaining SOEs will still enjoy unfair rules of competition and thus stymie the private sector. This is evidenced by the fact that some SOEs have been privatized to date, and yet domestic private firms remain small and unproductive.

Chapter IV – New Economic Value Chains

I. Research Question

Developing-world policymakers are increasingly worried about how automation technologies could halt their capacity to move up the economic value chain. Traditionally, developing countries have grown via export strategies, where increasingly sophisticated exports are produced building on knowledge of existing production techniques. Automation, however, could reshore some exports to be produced in the developed world with robotics instead of human labor. Depending on the products that are reshored, developing countries may need to find alternative export sequences.

In this chapter I aim to determine how the evolution of developing-world export baskets would respond to hypothesized disruptions in the export value chain. I approach the problem through the lens of a special-purpose economic analysis tool for exports: the product space, where exports are viewed as a network of related products (Hidalgo and Hausmann 2009). This network treats particular exports as nodes and weighs edges between them based on how frequently they are co-exported. By taking into account both the relationships between products and historical data, I am able to construct a machine learning model that exploits both time series and network properties of export evolution. Having built a model that predicts how export baskets evolve, I apply it to alternative product space networks that reflect hypothesized disruptions from automation.

II. Data and Methods

Historical trade data is obtained from the Harvard Atlas of Economic Complexity, while supplementary country data is obtained from the World Bank. Trade data is SITC coded at the four-digit level. It categorizes exports into 792 product types, and covers 1962 - 2016. I specifically use the following variables:

- Revealed Comparative Advantage (RCA): specific to a certain product for a certain country in a certain year. Defined as the ratio of that product's share in the country's total exports to that product's share in world exports. If an RCA is equal to or greater than one, a country is considered to have a comparative advantage in a particular export, as it exports more than one would expect from the average country.

- Country's Export Value of Product: the constant USD value of a country's export of a certain product in a certain year.
- Country's Total Export Value: the constant USD value of all of a country's exports in a certain year.
- World Export Value of Product: the constant USD value of all worldwide exports of a product in a certain year.
- Diversity: the count of the number of exports in which a country has an RCA of at least one.
- Ubiquity: the count of how many countries have an RCA of at least one for a particular product.
- Economic Complexity Index: an index provided by the Harvard Atlas of Economic Complexity that captures how sophisticated a country's export basket it. Based on the ubiquity of the products a country has an RCA of at least one in and the diversity of the countries which export that product.
- Product Complexity Index: an index provided by the Harvard Atlas of Economic Complexity that captures how sophisticated a product is to produce. Based on the average diversity of countries that make the product in question and the average ubiquity of their other products.
- GDP per Capita: the income per person of a country, in constant USD.
- Resource Rents as a Share of GDP: the percent of a country's GDP that comes from natural resources.

I analyze 35 countries that are executing or have the potential to execute export-led growth, both for computational feasibility and to hone the model on the sorts of economies to which this research question primarily pertains. This set of countries is obtained by winnowing from a list of all countries based on three criteria: first, having a maximum observed GDP per capita between $1,000 and $15,000; second, discarding countries with especially low maximal Economic Complexity Index values; and third, discarding countries with low average Economic Complexity Index percentage growth rates over the last twenty years. This yields a list of countries which approximately correspond to major emerging markets around the world: Algeria, Argentina, Bulgaria, Bosnia and Herzegovina, Belarus, Brazil, Chile, China, Colombia, Costa Rica, Egypt, Guatemala, Indonesia, India, Jordan, Sri Lanka, Morocco, Mexico, Macedonia, Malaysia, Pakistan, Panama, Peru, the Philippines, Romania, Russia, Senegal, South Africa, Thailand, Tunisia, Turkey, Ukraine, Uruguay, Venezuela, and Vietnam. These countries are examined over the full time period 1962 – 2016.

On a high level, my strategy is to feed product space networks into the GraphSAGE machine learning model (see Hamilton, Ying, and Leskovec 2017), where time series data relevant to particular products and countries has been assigned to each node. This model is well-suited to my task because it predicts node properties based on neighbors' attributes and is built to handle dynamically-changing networks. Thus it can interpret the relationships between products in the network, learn general rules about export evolution that are not specific to particular countries' graphs, and be adapted to new networks that reflect disruption from automation. I treat each country in each year as a separate community to be fed into the GraphSAGE model. For example, Malaysia in 2010 would constitute one set of connected nodes, while it would not be connected to Vietnam in 2010 nor Malaysia in 2005. My outcome variable to predict is changes in RCA (the first difference is predicted to ensure stationarity of the time series), while other variables described above plus lagged RCA values constitute input variables.

To begin the implementation, I calculate a matrix of each product's probability of being co-exported with another product over the entire available time period. I keep the six strongest relationships for each product to highlight important relationships while reducing computational needs. This matrix is then converted to an edge list, which is used in all communities. Additionally, I apply a spring force layout algorithm to this edge list to obtain relative positions for each product. I initially create this in 50 dimensions, then apply Principal Component Analysis to reduce it to 12 (which explains nearly all the variance). This yields a vector for each product that represents how each one is related to others along 12 dimensions, which serve as additional input variables.

I then merge World Bank and trade data together to form a matrix where each row uniquely identifies a particular product in a particular year as exported by a particular country, and each column identifies an input variable. The input variables are those described above, where some are specific to a country, some to a product, and some to a country's export of a product. Lags, rolling means, and rolling standard deviations over five years are obtained for those variables which change over time. I additionally create binary indicators for particular countries and years to capture omitted country variables and year-specific shocks. This yields a total of roughly 300 input variables. The obtained edge list and matrix of input data is then converted to a network format. Each edge weight comes from the edge list, and each node is assigned input data in addition to the desired output to predict – changes in RCA five years out.

Having created these communities, I then generate the modified versions of the product space that represent possible automation scenarios. I create four automation scenarios of increasing severity,

where industries are assigned certain overall probabilities of automation. The literature generally considers manufactures to be somewhat more susceptible to automation than agricultural goods or raw materials (The Center for Global Development 2018); accordingly, I consistently assign manufactures to have a 10% higher chance of being automated than those alternatives. In the first scenario manufactures have only a 10% chance of automation, while in the last they incur a 40% chance of automation. Within each scenario I generate a set of Monte Carlo simulations, where each product is automated with the aforesaid probability. Seeing as I aim to model the consequences of automation placing products beyond the reach of developing countries, I treat an automated product as having simply been deleted from the Product Space.

To be sure, this is a highly specific model of export evolution and automation which contains strong assumptions. For instance, there are limited implicit international effects which in reality may be significant. If one country starts moving into a particular export it may affect the market for others. However, it is unclear how to introduce such effects into the model; explicitly linking countries' export networks together could introduce substantial noise which would be difficult to process. Indeed, a node for a particular product from a particular country would then be linked to more products from *other* countries than from the home country. It is thus far more tractable to consider country-year communities in isolation, though this is certainly a simplification of reality. In addition, automation may not strictly proceed by instantaneously deleting nodes from the networks of developing countries. In reality this may be a complex transition, in which the node's relationships to other products changes over time. However, modeling this drift would require strong assumptions about every node's trajectory. What new products would it become related to in each year? How quickly would these relationships change? Again, it is simpler and more tractable to assume these nodes become out of the reasonable reach of developing countries and thus delete them, even if this means the model most represents especially sudden and severe automation.

Having prepared the input data I divide the historical, non-automated data into training and testing sets. I allocate 50% of the data to each group, randomized at the country-year level. Seeing as any given country only specializes in a handful of exports, I oversample active exports for the training data. Otherwise the algorithm is excessively biased to predict no change in the RCA. Having tried a variety of approaches to oversampling, I find the optimal technique to be oversampling exports with an RCA consistently above one or with an RCA that changes over the critical threshold of one in the prediction period.

I construct the GraphSAGE model's neural network to use two hidden layers with 128 nodes each, each using a Rectified Linear Unit (ReLU) activation function, and a dropout rate of 30%. Additional hidden layers or nodes do not appear to improve accuracy. The output layer uses a linear activation function, seeing as I aim to predict both positive and negative values over a range beyond -1 to 1. I use a mean squared error loss function, which I find produces better performance than alternatives such as mean absolute error or mean squared logarithmic error. I employ an Adam optimizer with an initial learning rate of 0.001, and train on 20 epochs with a batch size of 50.

III. Results

First, I check the prediction accuracy of my model by converting changes in the raw RCA value to changes in status of being below or above the critical threshold of 1. I prefer to optimize for this metric because I am qualitatively trying to predict new exports in which a country may specialize; the exact extent to which a country goes beyond or falls below the critical threshold of 1 is less important to me. I obtain the following F1 scores for out-of-sample RCA status prediction:

Table 1. F1 Scores for Out-of-Sample Prediction.

	F1 Score	**Precision**	**Recall**
RCA: Below 1 → Above 1	36%	32%	40%
RCA: Above 1 → Below 1	51%	58%	46%

While at first blush these scores might seem low, for the problem at hand I feel they are satisfactory. This is a detailed economic forecast which aims to predict export changes for hundreds of products across thirty-five countries. Even forecasts of singular economic variables are notoriously inaccurate, as it is very difficult to model systems as large and complex as national economies. This model is exactly correct in predicting new export gains more than a third of the time, and predicts roughly the right number of export gains (as shown by the similarity of the precision and recall scores). It is easy to imagine how nuances of historical circumstances or market conditions might create substantial noise in the exports a country moves into.

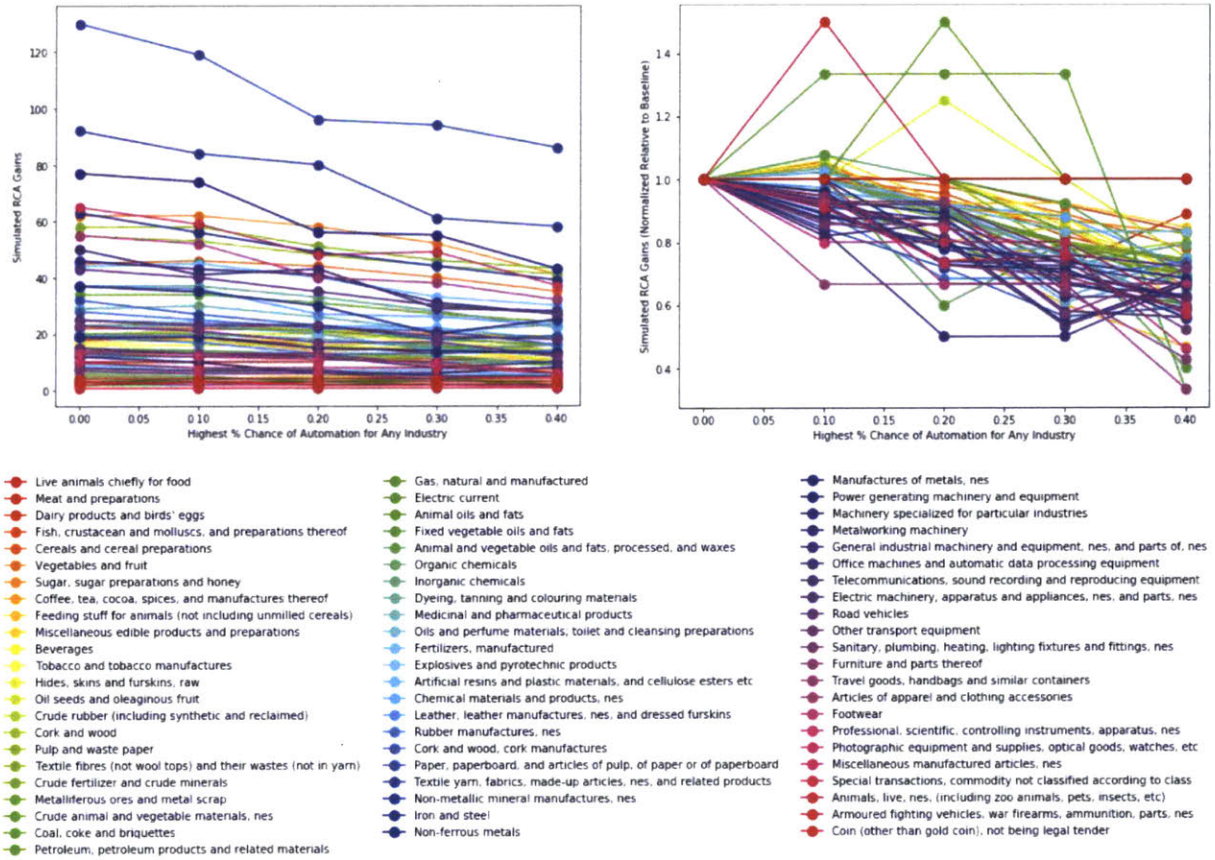
Having established that this model has reasonable predictive accuracy, I graph the average results of Monte Carlo simulations for different automation scenarios below. Specifically, I examine how simulated

exports gains (the number of products which move from below to above the critical RCA threshold of 1) varies for each country and industry among different scenarios, both in absolute and relative terms.

I want to avoid making predictions about the exact countries or industries that will be worst-affected, as these simulations are just the result of one model and ought not to be over-interpreted. Instead, I feel the true value of this exercise is to take note of general patterns in the results and draw broad, robust conclusions that are likely to be good policy advice in a wide variety of economic circumstances. With that in mind, a few key observations can be made.

First, the model appears to simulate countries moving along alternative export growth paths as certain products are automated. This is evident from the relative RCA gains for different industries as shown in Figure 1: a handful of industries exhibit *more* RCA gains than the baseline as the severity of automation increases. Perhaps unsurprisingly, the industries for which this is true tend not to be in manufacturing; that is, they were assigned lower automation risks by construction. We might, as such, expect that while automation reduces export growth in badly-affected sectors, it could actually increase activity in less-affected industries (global demand allowing).

Figure 1. Absolute and Relative RCA Gains with Varying Automation Severity by Industry.



Second, despite these figures reporting the average results of Monte Carlo trials – recall that broad groupings of industries, like all of manufacturing, were assigned consistent automation probabilities – there is substantial variation in the percentage losses seen. This indicates that some industries are more or less susceptible to disruption from automation based on their positions in the product space network. In absolute terms the ten worst-affected industries (there are 67 total) account for over 40% of losses in the worst automation scenario as compared to the baseline. Examples of the worst-affected industries include textile fabrics, metal manufactures, non-metallic mineral manufactures, articles of clothing and apparel, and industrial machinery.

Third, country-level RCA loss trends exhibit definite discontinuities as the probability of automation increases (see Figures 2 and 3). There are numerous junctions at which the slope of a country's trend changes, and in many cases there are diminishing marginal losses with increasing automation severity. This further supports the contention that the shape of the product space network strongly influences the effects of export disruption.

Figure 2. Absolute and Relative RCA Gains with Varying Automation Severity by Country, GDP per Capita Under $7000.

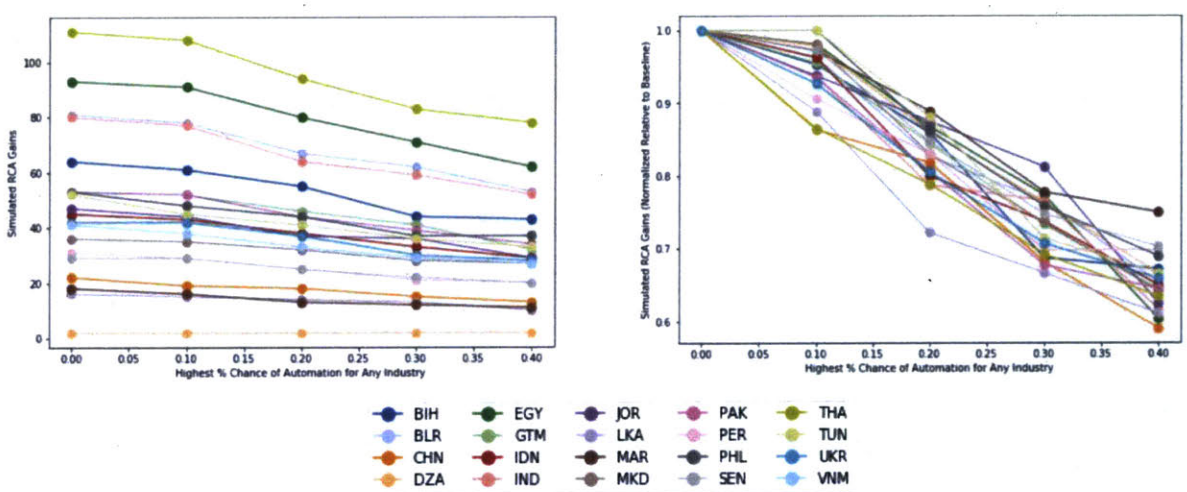
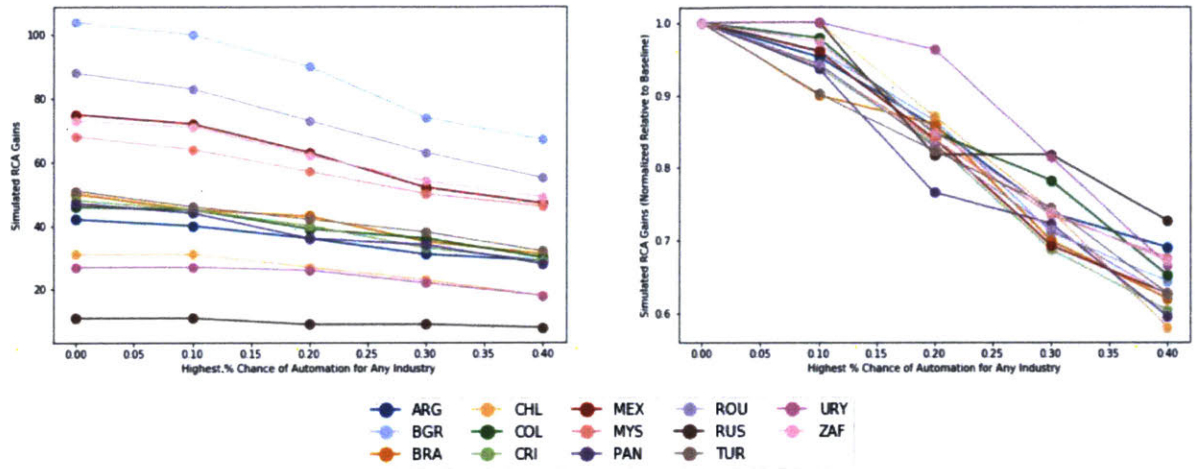


Figure 3. Absolute and Relative RCA Gains with Varying Automation Severity by Country, GDP per Capita Above $7000.



IV. Discussion

The above results indicate a strong role for the structure of the product space network in the determination of how automation influences export disruption. Some industries experience more activity as others are automated, while there are distinct discontinuities in the extent to which both industries and countries are affected as the severity of automation increases.

This makes sense in light of the underlying graph structure of the product space. A country's goal is to move from low-value to high-value nodes in the network, and products do not have uniform relationships between them. There are bottlenecks along the way where there are comparatively fewer options to branch out into new, higher-value exports. The effect of automation in this model, then, is to make bottlenecks even narrower or break them entirely: random node deletion in sparse portions of the graph is likely to substantially disrupt connectivity, while that in densely-connected parts will have a comparatively minor consequence. We would expect this formulation of automation to first strongly affect countries as those bottlenecks are disrupted, and then affect them more mildly on the margin because the remaining areas for them to grow into are more likely to be densely-connected – a pattern observed in some of the results.

The major policy lesson of this chapter, then, is that export diversification can make countries more resistant to automation. The more paths forward a country has available to it, the more likely it will be able to proceed to higher-value products if some of those paths are disrupted. Naturally this may entail

a trade-off between more secure versus faster but riskier growth. Certain industrial strategies, for instance, might favor concentrating on a few high-payoff sectors in favor of others. Conceivably this could accrue rapid economic growth through economies of scale. However, it would also risk being cut off from future growth if automation were to hem in future paths for export upgrading.

Chapter V – Conclusion

There is abundant concern among developing-world policymakers that automation will halt prospects for export-led growth. This thesis has aimed to answer research questions that can illuminate how developing countries can respond to that threat. It examined both the effectiveness of different economic strategies and the means of achieving them. Generally it finds that while automation may constitute a paradigm shift in technology, good responses are more likely to be reapplications of conventional policy.

This thesis began by examining the incentives behind industrial policy expenditure in the EU. New Industrial Policy literature (see Rodrik 2004) contends that particular institutional environments shape the incentives surrounding industrial policy and thus the ways in which it can be feasibly implemented. As such Europe was chosen to provide an analytical context with relatively high institutional quality and low levels of corruption in order to investigate this contention. The characteristics of industries that receive state aid funds were tested against four hypotheses: that EU governments direct state aid towards export-competitive industries; that they direct state aid towards industries with high output levels; that they direct state aid towards industries with high employment levels; and that they direct state aid towards industries in decline. Regression analysis across EU countries and industries was conducted, and it was found that industries with low levels of export competitiveness and those with high, declining levels of export competitiveness are generally targeted. This indicates that the EU institutional environment does not support outright corruption in state aid, as might be seen if high-output industries captured high proportions of spending. Politicians nevertheless appear to target industries which, if given additional support, would help create perceptions (based in material reality or not) of economic health through enhanced export competitiveness – even though this practice is strictly outlawed by supranational EU rules. It would seem, as such, that the New Industrial Policy hypothesis is supported: the specific institutional environment a decision-maker operates in influences how they will direct industrial policy. In the context of the EU outright corruption and vote-purchasing is quite plausibly unacceptable, but there is scope to support and foster national champions. Thus policymakers in developing countries should likewise be attentive to the institutions and incentives surrounding the agents who manage industrial policy, and design mechanisms that will both succeed economically and be incentive-compatible. Any effort to respecialize an economy in response to the threat of automation needs to be undertaken with this constraint in mind.

Second, this thesis conducted a growth diagnostics analysis of Vietnam to provide a detailed case study exploration of the factors which may hold back technological change in developing, export-driven economies. It began by noting that multifactor productivity growth – a key indicator of technological progress – in Vietnam substantially lags behind peer countries across virtually all industries. It then considered the domestic- and export-oriented sections of the economy in depth, considering how they might be constrained by the rules of competition surrounding state-owned enterprises, education, access to finance, public goods, and urban development. The first two issues were found to be binding, while others were not. It was shown that provinces with stronger State-Owned Enterprise presences have smaller domestic private firm sizes and employment levels, that State-Owned Enterprises enjoy decisively preferential access to land and financing, and that the FDI sector, which receives a separate allotment of resources which are not in competition with State-Owned Enterprises, exhibits far higher productivity than the domestic private sector. It was also shown that while returns to advanced education in Vietnam are very high, export businesses consistently report skill shortages and pay the second-highest premium to skilled expatriates of any country in Southeast Asia after Singapore. University-educated Vietnamese immigrants to the US, furthermore, earn less than immigrants from neighboring countries with similar formal education levels, indicating problems with the quality of higher education in Vietnam. While these structural issues were shown to hold back productivity growth in the domestic- and export-oriented sectors respectively, more technocentric issues were found to have lesser importance. Internet access, for example, is poor in quality in Vietnam but also quite inexpensive; if it were a binding constraint to growth one would expect higher prices resultant from high demand. This analysis shows that technological progress, as measured by productivity growth, in Vietnam is not chiefly held back by the absence of cutting-edge Industry 4.0 infrastructure but rather by conventional economic factors.

Finally, this thesis modeled the impact of automation on the export trajectories of 35 emerging markets. It constructed the export portfolios of each country as a product space network (see Hidalgo and Hausmann 2008) where each node corresponds to a product and edges between nodes are weighted by the probability that they will be exported together by any country. This approach to modeling the evolution of export trajectories takes into account the relationships between products, where knowledge of one may be useful for learning how to produce certain others. Time series data pertaining to the products and countries in question were assigned to each node. Four increasingly severe automation scenarios were constructed by assigning increasing automation probabilities to different industries, and Monte Carlo simulations were generated by randomly deleting nodes according to the

probability assigned to their industry. The historical data was fed into a GraphSAGE machine learning model, which learned how to predict changes in a country's export portfolio five years into the future. This model correctly predicted more than a third of the exact new exports a country would move into, and forecasted approximately correct numbers of new exports in total. The model was then used to predict changes in a country's export portfolio under the Monte Carlo simulations of each automation scenario, which were compared to each other and the baseline scenario of no automation. Average new export acquisitions were reported for different countries and industries. It was found that some industries exhibited increased export activity as a result of automation as compared to the baseline, suggesting that countries might respecialize their export baskets towards towards new industries if others are automated. It was also found that despite reporting averages from Monte Carlo simulations, the marginal effects of increasing automation severity on export gains for particular countries were often visibly disjointed and diminishing. This is best explained by the network properties of the product space. Some areas of the network have higher connectivity than others, and those areas with bottlenecks are most vulnerable to disruption in the form of random node deletion. As such minimal levels of automation would be liable to disrupt sensitive bottlenecks, and thereafter higher automation probabilities would affect more densely-connected parts of the network with correspondingly lower consequences for connectivity. The disruption of these bottlenecks, to which countries are varyingly exposed depending on their particular export portfolios, would explain the sudden jumps in export losses seen among certain countries. The major takeaway from this analysis is rather intuitive: export diversity could shield countries from the effects of automation by ensuring as many paths as possible remain to higher-value products.

Collectively this evidence calls into question moonshot, technocentric strategies which would attempt to bring cutting-edge innovation to the immediate fore of developing economies. It suggests that developing countries can diversify their export portfolios to hedge their bets against automation; that the best way to accelerate productivity, key to making those advances, is to address structural economic issues (which are country-specific as opposed to uniform); and that in executing those industrial strategies policymakers should be deeply cognizant of the institutional settings they operate in to avoid pitfalls such as waste and corruption. This does not constitute any sort of a new economic paradigm in the world of automation, but rather a reaffirmation and perhaps a reapplication of conventional wisdom.

These conclusions only touch the tip of the iceberg of useful research on developing-world policy responses to automation. All of the above analyses could be extended in of themselves: incentives behind industrial policy could be examined outside of Europe, growth diagnostics could be done for additional countries facing productivity issues, and export trajectories under automation could be predicted with new models, assumptions, and timeframes. Other potential areas of interest include how developing countries could realistically make (perhaps limited) use of automation technologies, how demand for developing-world exports could change in developed nations affected by automation, and how the nature of trade itself could change as it becomes facilitated by automation.

References

A.T. Kearney: "Competitive Benchmarking: Sri Lanka Knowledge Services 2012".

Ades, Alberto, and Rafael Di Tella. "National champions and corruption: some unpleasant interventionist arithmetic." The Economic Journal 107.443 (1997): 1023-1042.

Agénor, Pierre-Richard, Otaviano Canuto, and Michael Jelenic. "Avoiding middle-income growth traps." (2012).

Auty, Richard M. "Industrial policy capture in Taiwan and South Korea." Development Policy Review 13.3 (1995): 195-218.

Bassino, Jean-Pascal. "Preliminary Estimates of Vietnam GDP (1800–1970): North–South Economic Divide in Historical Perspective." *International Workshop on Asian Historical Statistics Database, Tokyo: Hitotsubashi University, Institute of Economic Research, January*. 2001.

Barker, T. and Üngör, M. "Vietnam: The Next Asian Tiger?", University of Otago, Economics Discussion Papers No. 1803. March 2018. Dunedin, New Zealand.

Bergström, Fredrik. Essays on the political economy of industrial policy. Economic Research Institute, Stockholm School of Economics [Ekonomiska forskningsinstitutet vid Handelshögsk.], 1998.

Camen, Ulrich. "Monetary policy in Vietnam: the case of a transition country". Swiss State Secretariat for Economic Affairs, SECO. Geneva, Switzerland.

"Correspondence Tables." Eurostat, http://ec.europa.eu/eurostat/web/nace-rev2/correspondence_tables.

Dewatripont, Mathias, and Paul Seabright. "'Wasteful' public spending and State aid control." Journal of the European Economic Association 4.2-3 (2006): 513-522.

Dür, Andreas. "Interest groups in the European Union: how powerful are they?" West European Politics 31.6 (2008): 1212-1230.

Gual, Jordi, and Sandra Jódar-Rosell." Vertical industrial policy in the EU: an empirical analysis of the effectiveness of state aid." (2006).

Hamilton, Will, Zhitao Ying, and Jure Leskovec. "Inductive representation learning on large graphs." Advances in Neural Information Processing Systems. 2017.

Hidalgo, César A., et al. "The product space conditions the development of nations." Science 317.5837 (2007): 482-487.

Kassim, Hussein, and Bruce Lyons. "The new political economy of EU state aid policy." Journal of Industry, Competition and Trade 13.1 (2013): 1-21.

Le Duy Binh and Doan Hong Quang. "Are There Preferential Treatments of SOEs: Evidences from Practice". The World Bank Group and Central Institute for Economic Management, 2015. Hanoi, Vietnam.

Loewe, Markus. "Industrial policy in Egypt 2004-2011." (2013).

McCaig, Brian and Nina Pavcnik. "Moving out of agriculture: structural change in Vietnam". National Bureau of Economic Research (NBER). Cambridge, MA. 2013.

"National Accounts Aggregates by Industry (Up to NACE A*64)." Eurostat, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_a64.

"National Accounts Employment Data by Industry (Up to NACE A*64)." Eurostat, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_ a64_e.

Nguyen Thi Nguyet. "Fiscal Policy and Provincial Growth: The Case of Vietnam". Central Institute for Economic Management (CIEM) - Ministry of Planning and Investment (MPI), Hanoi City, Vietnam

Nicolini, Marcella, Carlo Scarpa, and Paola Valbonesi." Aiding car producers in the EU: money in search of a strategy." Journal of Industry, Competition and Trade 13.1 (2013): 67-87.

Phan Minh Ngoc. "Sources of Vietnam's Economic Growth", Faculty of Economics, Kyushu University. Tokyo, Japan.

"Product Concordance." World Integrated Trade Solutions, https://wits.world bank.org/product_concordance.html.

Potters, Jan, and Randolph Sloof." Interest groups: A survey of empirical models that try to assess their influence." European journal of political economy 12.3 (1996): 403-442.

Robinson, James A. "Industrial policy and development: A political economy perspective." Washington, DC: World Bank(2009).

Rodrik, Dani. "Industrial policy for the twenty-first century." (2004).

Sarma, V., Saumik Paul, and Guanghua Wan (2017). “Structural Transformation, Growth, and Inequality: Evidence from Viet Nam”. Asian Development Bank Institute. Tokyo, Japan. 2017.

"State Aid Transparency Public Search." European Commission, https://webgate. ec.europa.eu/competition/transparency/public.

Tarp, van Seventer et al. “Growth and structural transformation in Viet Nam during the 2000s”. WIDER Working Paper 2016/108. UNU-WIDER, Helsinki, Finland, 2016.

The World Bank Group. “Vietnam’s Labor Market Institutions, Regulations, and Interventions”. Washington DC, USA.

The World Bank Group. “Doing Business Report 2018”. Washington DC, USA.

The World Bank Group. “Enterprise Survey – Vietnam 2015, 2016, 2017, 2018”. Washington DC, USA.

The World Bank Group and the Government of Vietnam (2017). “Vietnam Public Expenditure Review (PER): Fiscal Policies towards Sustainability, Efficiency, and Equity”. Washington DC.

"World Development Indicators." The World Bank, http://databank.worldbank.org /data/reports.aspx?source=world-development-indicators.

UNESCO, UNDP, IOM, and UN-Habitat. “Overview of Internal Migration in Viet Nam”, Policy Briefs on Internal Migration in Southeast Asia. Bangkok, Thailand.