Growth and Change in the Vietnamese Labour Market:
A decomposition of forecast trends in employment over 2010-2020

J. A. Giesecke, N. H. Tran, G.A. Meagher and F. Pang
Centre of Policy Studies
Monash University

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Contents

LIST OF TABLES

LIST OF FIGURES

APPENDIXES

1 INTRODUCTION

1.1 Policy background

The Government of Vietnam's latest Socio-Economic Development Strategy (SEDS) sets out development plans aimed at speeding the country's industrialisation, modernisation, and economic development over the period 2010 to 2020. The strategy notes that in the past education and training planning has not been well aligned with employment growth, resulting in significant mismatches between labour demand and labour supply for certain occupations and qualifications. The current plan recognises that an important factor in achieving its 2020 development goals is a skilled and adaptable workforce. To this end, the SEDS accords education policy a key role in facilitating the country's economic growth. As we shall show in this paper, the process of Vietnam's economic development can be understood not only in terms of the broad sweep of economic growth, but also in terms of the structural composition of this growth. In particular, planning for the country's future workforce should take account of both the level and the composition of the country's forecast growth. This requires an analytical tool that can accommodate the large amounts of economic detail necessary for the production of convincing labour market forecasts. Computable general equilibrium (CGE) models are well equipped for this task, since they recognise many of the microeconomic variables that have a bearing on labour market outcomes. These include variables describing changes in government policy, changes in the country's foreign trading environment, and changes in the underlying structure of the economy. This paper describes the development and application of such a large-scale CGE model for Vietnam, one which places particular emphasis on the role of the demand for, and supply of, labour distinguished by occupation and level of educational attainment. Hereafter, we refer to this model as the VNET (for Vietnam education and training) model.

We use VNET to forecast changes in the Vietnamese economy between 2010 and 2020. Our forecast is the product of a large amount of microeconomic and macroeconomic detail input to the VNET model. The methodology we employ is derived from that used in historical/decomposition analysis with CGE models, but our focus is the future rather than the past.[1] In common with its antecedent historical analysis, a particular strength of the forecasting methodology is its capacity to decompose forecast outcomes for any endogenous variable into individual contributions made by the forecast changes in the various exogenous variables, such as those describing economic structure, government policy and the external trading environment. This is an aid to policy makers with responsibilities in labour force planning. It facilitates transparency in forecasting by clearly distinguishing the factors responsible for generating a particular forecast outcome. It promotes constructive discussion and debate by providing a ranking of causal factors in terms of the magnitudes of their impacts on forecast variables. Finally, it facilitates focused sensitivity analysis. Indeed, by allowing researchers and policy makers to distinguish the influences that are important from those that are unimportant, research effort can be concentrated on those factors that have the most bearing on the outcomes forecast for the labour market.

[1] Historical analysis with CGE models was pioneered by Dixon and Rimmer (2002). An application of the technique to explaining the recent history of Vietnam's economic development is Giesecke and Tran (2009).

1.2 Forecasting and decomposition simulations with a detailed CGE model

To produce forecasts with the VNET model, and decompose these forecasts into contributions by individual exogenous factors, we undertake two simulations with the model. Hereafter, we shall refer to these simulations as the "forecast" and "decomposition" simulations. To describe these simulations, we begin by noting that a CGE model like VNET can be described by F(X) = 0; where F is an *m*-vector of differentiable functions of *n* variables, X.[2] Since $n > m$, $n - m$ variables must be determined exogenously by the model user. X includes such variables as prices, quantities, employment, wages, tax rates, production coefficients, and household tastes. The *m* equations of F(X) embody the theoretical structure of the model as described in Section 2. An initial solution to F(X) = 0 is provided for the year 2010. In running the model, deviations from this initial solution are calculated for *m* endogenous variables given the user-specified values of $n - m$ exogenous variables. There are many economically sensible choices of which of the model's *n* variables can be determined exogenously by the model user. Two choices among the possible sets of $n - m$ exogenous variables are relevant to the present project: that defining the "forecast" closure; and that defining the "decomposition" closure. In defining these two closures more precisely, it is convenient to partition the variables of the model into four sets: $X(\overline{F},\overline{D})$, $X(F,D)$, $X(\overline{F},D)$ and $X(F,\overline{D})$, where:

$\overline{F}$ denotes exogenous in the forecast simulation;
F denotes endogenous in the forecast simulation;
$\overline{D}$ denotes exogenous in the decomposition simulation; and
D denotes endogenous in the decomposition simulation.[3]

Hence,

$X(\overline{F},\overline{D})$	is comprised of those variables that are exogenous in both the forecast and decomposition simulations;
$X(\overline{F},D)$	is comprised of those variables that are exogenous under the forecast simulation, but endogenous under the decomposition simulation;
$X(F,\overline{D})$	is comprised of those variables that are endogenous under the forecast simulation, but exogenous under the decomposition simulation; and
$X(F,D)$	is comprised of those variables that are endogenous under both the forecast and decomposition simulations.

Table 1 describes selected elements of $X(\overline{F},\overline{D})$, $X(F,D)$, $X(\overline{F},D)$ and $X(F,\overline{D})$.

$X(\overline{F},D)$ and $X(F,\overline{D})$ contain the same number of elements, and a readily apparent economic relationship can be described between the individual elements of each. We exploit these relationships to allow the elements of $X(\overline{F},D)$ to be set exogenously at independently given values during the forecast simulation (with corresponding elements of $X(F,\overline{D})$ determined endogenously) and endogenously during the decomposition simulation (with corresponding elements of $X(F,\overline{D})$ set exogenously at their values under the forecasting simulation). $X(\overline{F},D)$ contains variables that we normally would expect to find among the endogenous variables in a standard closure of a CGE model. Hence they belong to the set D. However, independent forecast values for these variables are available from independent forecasters, such as the World Bank, so they also belong in the set $\overline{F}$.

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[2] See Dixon and Rimmer (2002: 10-15).

[3] In describing this partition, we have adapted to a forecasting application the description of model closure under historical and decomposition simulations as set out in Dixon and Rimmer (2002: 11-15).

Table 1.Status of key variables under the forecast and decomposition closures

A. Variables endogenous under decomposition closure, exogenous and shocked in forecast closure $X(\overline{F},D)$	**B. Corresponding variables which are exogenous under decomposition closure, endogenous in forecast closure** $X(F,\overline{D})$
• Real GDP • Terms of trade • Qualification-specific wage relativities	• Economy-wide primary-factor productivity • Shifts in export demand schedules • Qualification-composition of aggregate training
C. Shocked variables which are exogenous in both forecast and decomposition closure , $X(\overline{F},\overline{D})$	
• Primary factor technology, by industry • Intermediate-input-using technology, by commodity • Occupation-specific input requirements • Consumer preferences, by commodity • Economy-wide import/domestic preference shifts • Economy-wide labour-capital twist • Consumer price index • Number of households and population • c.i.f. import prices in foreign currency • Tariff rates, value-added tax rates, export tax rates • Land use by industry	
D. Variables which are endogenous in both forecast and decomposition closure, $X(F,D)$	
• Wage rates by industry, occupation and qualification • Employment by industry, occupation and qualification • Capital stock by industry • Investment by industry • Demand for source-specific commodities for production, investment, private and public consumption • Export volumes by commodity • Commodity prices used in production, investment, consumption, and exports • Demand for margin *m* by agent *k* to facilitate purchase of commodity *c* from source *s*	

An example of a variable in $X(\overline{F},D)$ is real GDP. For the forecast simulation, we impose on the model the World Bank's forecast for Vietnam's real GDP. Hence real GDP is in the set $\overline{F}$. In the decomposition simulation, real GDP is endogenous, and thus also belongs to the set D. $X(F,\overline{D})$ contains variables that we would normally expect to find among the set of exogenous variables in a standard CGE application. Hence they belong in the set $\overline{D}$. However, in the forecasting simulation, these variables are endogenous, providing the model with the flexibility necessary to allow for exogenous determination of the variables in $X(\overline{F},D)$. An example of a variable in $X(F,\overline{D})$ is economy-wide primary factor productivity. This must be determined endogenously in the forecasting simulation, allowing the model to accommodate the exogenously specified value for real GDP. In the decomposition simulation, primary factor productivity is determined exogenously at the value determined during the forecasting simulation.

Having partitioned VNET's variables into the above four sets, the first application of the model (the forecast simulation) involves finding a solution to:[4]

$$X(F) = G^{(F)}\left(X(\overline{F})\right) \quad \text{(E1)}$$

where:

$X(F) \; = \; X(F,\overline{D}) \cup X(F,D)$;

$X(\overline{F}) \; = \; X(\overline{F},D) \cup X(\overline{F},\overline{D})$; and

$G^{(F)}$ is an m-vector of differentiable functions.

By assigning the variables in $X(\overline{F})$ their forecast 2020 values, $G^{(F)}$ is used to calculate the 2020 values for $X(F)$. Having calculated these values, we then undertake the decomposition simulation, finding a solution to the model of the form:

$$X(D) = G^{(D)}\left(X(\overline{D})\right) \quad \text{(E2)}$$

where

$X(D) \; = \; X(\overline{F},D) \cup X(F,D)$;

$X(\overline{D}) \; = \; X(F,\overline{D}) \cup X(\overline{F},\overline{D})$; and

$G^{(D)}$ is an m-vector of differentiable functions.

As Dixon and Rimmer (2002: 14) describe, following the method pioneered by Johansen (1960), (E2) can be expressed in log-differential or percentage change form as:

$$x(D) = B\, x(\overline{D}) \quad \text{(E3)}$$

where:

$x(D)$ is a vector of percentage changes in the endogenous variables;
$x(\overline{D})$ is a vector of percentage changes in the exogenous variables; and
B is an m x (n – m) matrix of elasticities.

The values for $x(\overline{D})$ are known from the forecasting simulation. This allows (E3) to be used to decompose the movements in $x(D)$ into the individual contributions of each of the movements in $x(\overline{D})$. In undertaking this decomposition, we use the algorithm developed by Harrison, Horridge and Pearson (2000).

As we shall describe in Section 3.3, the shocked elements of $x(\overline{D})$ comprise several hundred variables. For reporting, some summarization and aggregation of these shocks is thus necessary. In Section 4, where we discuss the results of our decomposition simulation, we aggregate the exogenous shocks into 11 broad groups of causal factor. In the next section, we presage our more detailed results by presenting a summary of the main results as they pertain to employment distinguished by industry, occupation and qualification. In doing so, we follow Giesecke and Tran (2009) in allocating the variables in $x(\overline{D})$ to four broad categories, namely, those relating to:

(i) domestic structural change (DS);
(ii) domestic factor supplies (DF);
(iii) foreign structural factors (FS); and

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[4] See Dixon and Rimmer (2002: 14).

(iv) domestic policy change (DP).

Domestic structural change (DS) comprises shifts in technical efficiency, household tastes, import/domestic preferences, and labour/capital bias in technical change. Domestic factor supply (DF) comprises changes in total new entrants to the workforce, and changes in land supply. Foreign structural factors (FS) comprises shifts in international trade conditions. Domestic policy change (DP) comprises changes in the public/private consumption ratio, changes in tariff rates, and changes in the qualification acquisition patterns of new entrants to the workforce. We briefly introduce the impact on employment by industry, qualification and skill of forecast changes in these four broad forces of economic change in Section 1.3 below.

1.3 Summary decomposition of trends in Vietnamese employment, 2010 – 2020.

Figures 1 – 4 summarise our labour market forecasts, decomposing forecast outcomes for employment by industry, occupation and qualification, and wage rates by qualification, into the individual contributions of forecast changes in domestic structural change, domestic factor supplies, foreign structural factors, and domestic policy change.

We begin with Figure 1, which reports the percentage change between 2010 and 2020 in employment distinguished by qualification. As discussed in Section 2.3.2, we model qualification accumulation between 2010 and 2020 as the sum of net new entrants to the labour force distinguished by qualification type. Our decomposition simulation allows us to distinguish two sources of contribution to qualification accumulation over the period:

(i) Accumulated net entrants to the workforce, under an assumption that qualification acquisition patterns of new workforce entrants remain at their 2010 proportions. This effect is reported as "domestic factor supply" in Figure 1.

(ii) Change in the qualification acquisition patterns of new entrants to the work force over the period 2010 to 2020. This effect is reported as "domestic policy change" in Figure 1.

In identifying these two effects, we are able to distinguish the general expansion in the size of the Vietnamese workforce, from the policy decision to favour training of certain qualifications relative to others.

Examining the contribution of "domestic factor supply" in Figure 1, we see that the 2010 qualification acquisition patterns of new workforce entrants is weighted towards university and college qualifications, and no qualifications, relative to vocational qualifications (whether short- or long-term) and professional high school qualifications. Indeed, were the attainment of short-term and long-term vocational training qualifications to remain at their 2010 rates over the forecast period, then gross permanent departures from the workforce of workers with these qualifications is forecast to exceed gross new entrants with these qualifications, leading to a net fall in employment in these skill categories. This accounts for the negative contribution of domestic factor supply growth to forecast growth in employment of workers with short-term and long-term vocational training qualifications. The weighting of 2010 qualification acquisition patterns towards university, college and no qualification skill categories is reflected in Figure 1 in positive growth in employment for these categories.

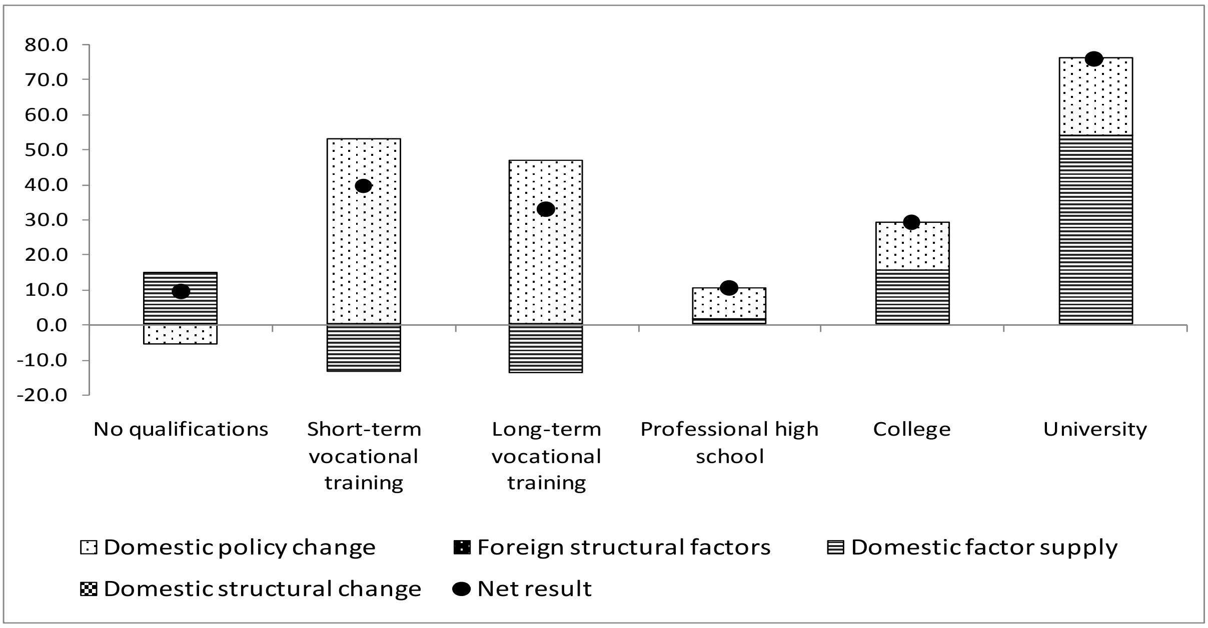


Figure 1. Employment annual average growth rate, by qualification, 2011-2020

However, as is clear from Figure 1, we do not assume that qualification acquisition patterns remain unchanged over the forecast period. Rather, we assume that educational resources are re-allocated towards training in those qualifications the relative wages of which would otherwise be rising. In Figure 2, this accounts for why our forecast wage movements for all qualifications are identical: that is, we assume that education policy is adjusted over the forecast period to achieve equality of wage growth outcomes across qualifications. As we discuss in Section 4.5, a policy of tailoring education programs, to promote acquisition of qualifications for which the relative demands are rising, generates significant welfare gains for Vietnam, of the order of $USD 260 per household per year in 2020. These shifts are identified in Figure 1 as "domestic policy change".

As is clear from Figure 1, we assume that education policy is realigned to reduce in general the number of people who acquire no qualification, and to promote in particular the acquisition of short-term and long-term vocational qualifications, and college and university qualifications. If qualification acquisition patterns were not realigned to promote employment growth in these qualifications, it is clear from Figure 2 that wage growth for these qualifications would be significantly higher than forecast. The corollary of this observation is that, by identifying and examining the causal factors for qualification-specific wage growth in Figure 2, we illuminate the likely sources of future pressure to adjust the allocation of educational resources across qualifications.

For short-term and long-term vocational training, part of the need to adjust qualification acquisition patterns simply arises from the fact that the initial rate of acquisition of these qualifications is too low. This leads to a negative contribution to employment growth for these qualifications in Figure 1. The resulting shortage of workers with these qualifications in 2020 results in a rise in their wage rate (Figure 2). Comparing the sizes of the "domestic factor supply" and "domestic policy change" contributions to wage growth for vocational qualifications in Figure 2, we can infer that part of the requirement to adjust training towards acquisition of vocational qualifications reflects the inadequacy of 2010 positions to simply meet the 2020 needs of the Vietnamese workforce even in the absence of changes in domestic structural factors and foreign structural factors.

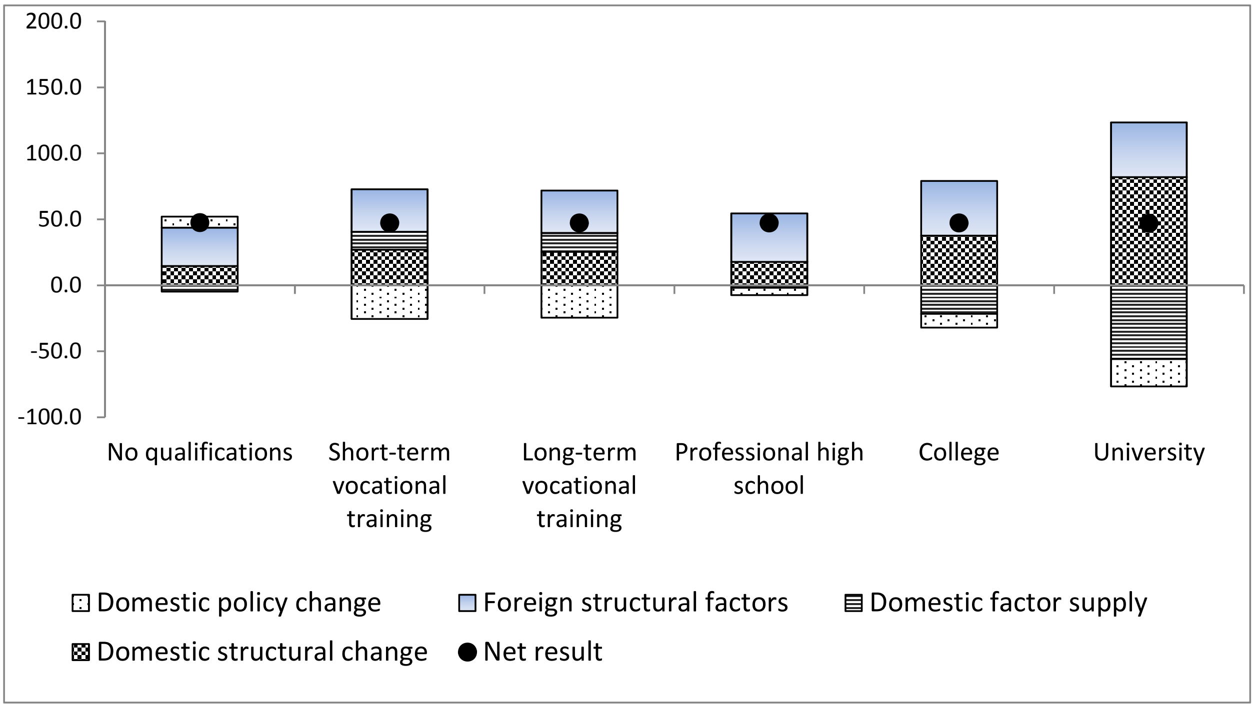


Figure 2. Wage rate annual average growth rate, by qualification, 2011-2020

The current (2010) pattern of qualification acquisition patterns appears somewhat better aligned to forecast 2020 workforce needs in the case of college and university qualifications. For these qualifications, we forecast that domestic structural change and foreign structural factors will place significant upward pressure on wage rates for these qualifications (Figure 2). This wage pressure is somewhat assuaged by the relatively heavy weighting of these qualifications in current skill acquisition patterns, domestic factor supply making a negative contribution to the wage outcome for these occupations in Figure 2. However, the initial weighting is not enough, and educational resources must be reallocated over the forecast period to promote even greater acquisition of college and university qualifications than that which would otherwise occur given the 2010 pattern of qualification acquisition. This accounts for the negative contribution of domestic policy change to the wage outcomes for college and university qualified workers in Figure 2.

Figure 3 summarises employment outcomes by sector. In general, employment outcomes are highest in the manufacturing and service sectors, and lowest in the agriculture and mining sectors.

Foreign structural factors, mainly representing growth in demand for Vietnamese exports, has an adverse effect on industries in the traded goods sector, such as agriculture, fishery, mining, selected manufacturing industries, hotels and restaurants, and sectors that facilitate international trade, such as transport and communications, and financial services. This, apparently counter-intuitive, outcome arises from the fact that growth in demand for Vietnamese exports causes national income to increase, and with it, national consumption. This is of assistance to industries in the non traded goods sector, not the traded sector. This is why, in Figure 3, we find that foreign structural factors promotes employment in sectors such as public administration, education, health care, construction and trade and repairs.

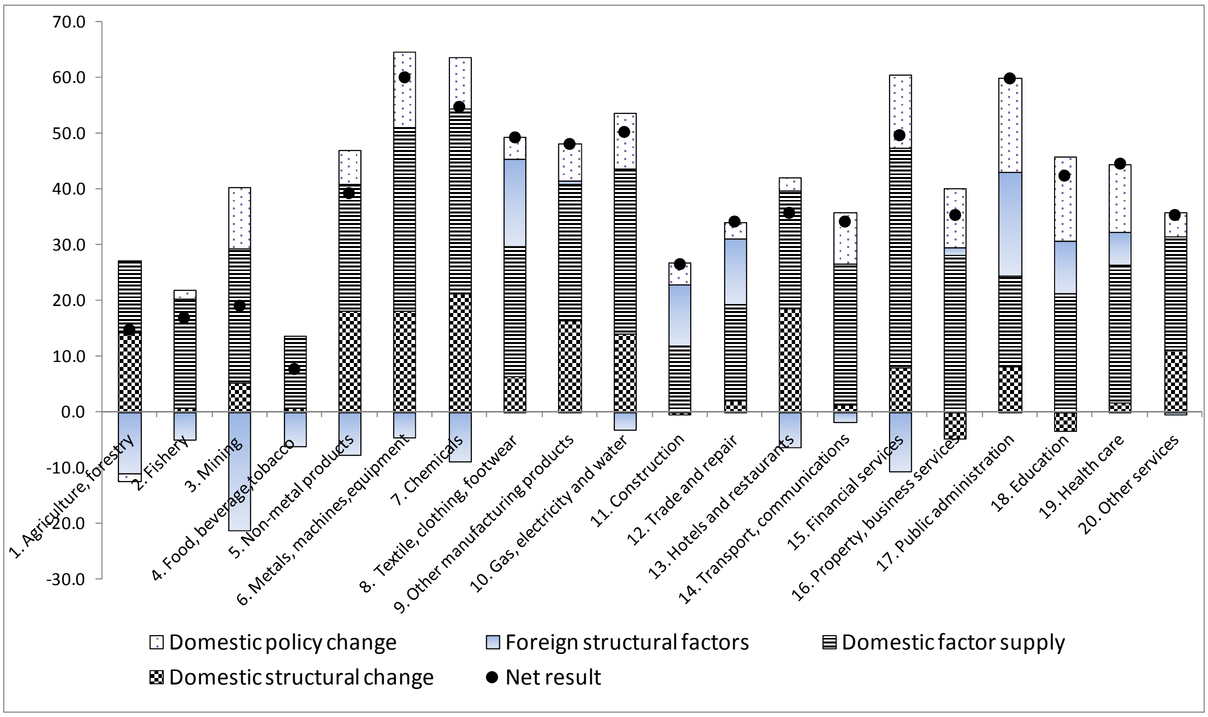


Figure 3. Employment annual average growth rate, by industry, 2011-2020

Our forecast assumes little change in the supply of natural resources, in the form of agricultural land and sub-soil assets, to the agricultural and mining sectors. This somewhat constrains their capacity to expand during the forecast period, adding to the reasons why these sectors are low-ranked in terms of employment expansion in Figure 3. Note that this fixity of natural resource supply also contributes to the low employment ranking of food, beverages and tobacco. This sector relies on inputs from agriculture. However agriculture's capacity to expand production to supply the food, beverage and tobacco manufacturing sector with inputs is constrained by the fixity of agricultural land supplies.

Domestic structural change is forecast to be an important contributing factor to the strong employment growth outcomes in the manufacturing sector, particularly in non-metallic mineral products; metal, machinery and equipment manufacturing; chemical manufacturing; and other manufacturing. A feature of our forecast is detail about trends in the input composition of current production and capital formation, and household construction. We forecast that these trends will favour increased use of certain manufactured goods, and services like finance.

Figure 4 describes the factors contributing to employment growth by broad occupational category. The occupations forecast to experience the highest rates of growth over the forecast period are high-level professionals and skilled workers in agriculture. As is clear from Figure 4, an important factor in explaining the forecast high level of growth for high-level professionals is domestic factor supply. In our interpretation of Figure 1, we noted that the 2010 pattern of qualification acquisition by new entrants to the labour force is weighted towards university qualifications. In Figure 1, this causes growth in domestic factor supply to make a large positive contribution to growth in university qualified labour. Workers with university qualifications exhibit a high propensity to work in the leader and manager, and high-level professional qualifications. This accounts for the strong positive contributions made by domestic factor supply to forecast employment growth in employment for these occupations in Figure 4.

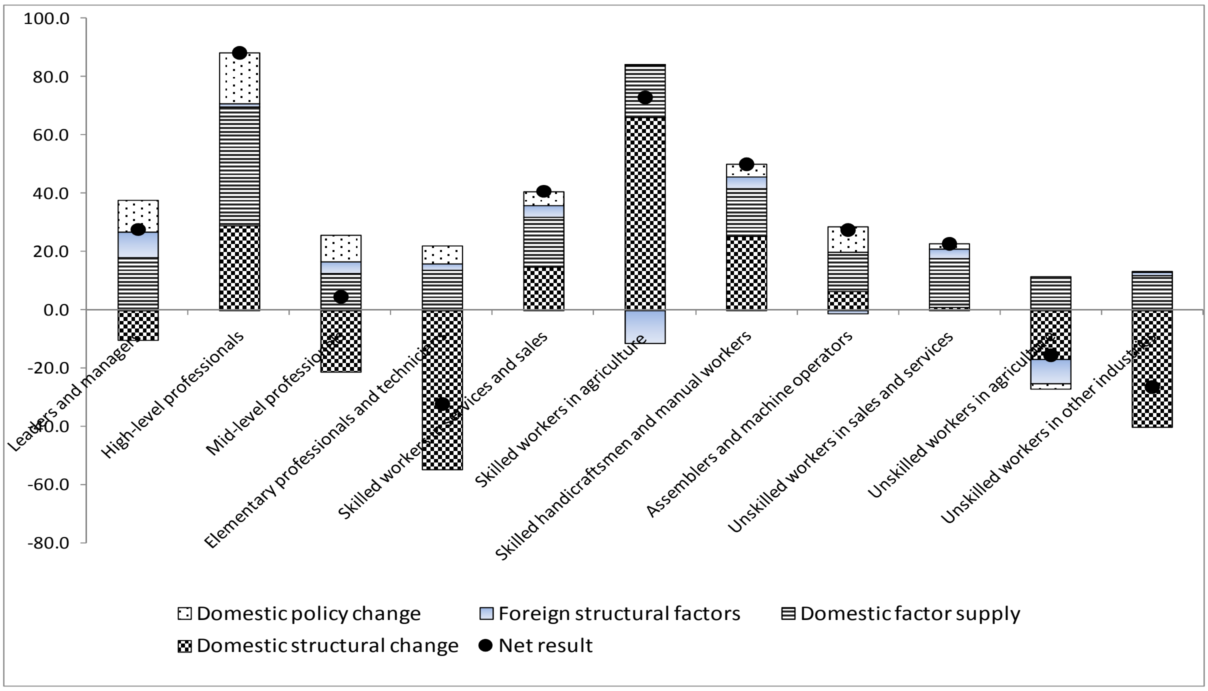


Figure 4. Employment annual growth rate, by occupation, 2011-2020

Figure 4 makes clear that domestic structural changes make a large contribution to forecast employment growth in a number of occupations. As we discuss in Section 3.3.8, an important feature of a forecast is extrapolation of historical trends in changes in the occupational composition of labour demand. Among other things these trends reveal shifts in the occupational composition of employment away from occupations such as mid-level professionals, elementary professionals and technicians, unskilled workers in other industries, and unskilled workers in agriculture. This accounts for the negative contributions made to employment growth in these occupations by domestic structural factors. At the same time, our forecast includes a continuation in the historical trend towards more intensive use of occupations such as high-level professionals, skilled workers in agriculture, and skilled handicraftsmen and manual workers. This accounts for the positive contributions to employment growth in these occupations made by domestic structural factors.

In the remainder of this paper we expand the above discussion, expanding on the details of the domestic policy changes, factor supply movements, foreign structural changes, and domestic structural changes summarized in Figures 1 – 4. As we shall see, our forecasts are determined by, and can be explained in terms of, a large number of forecast changes in technology, aggregate employment, qualification acquisition patterns, the international trading environment, occupation-specific input requirements, household tastes, and government taxing and spending policies. These shocks are discussed in Section 3.3. Naturally, our forecasts are determined by the input shock values discussed in Section 3.3. Policy makers often desire to understand how a change in input assumptions will change forecast results. As discussed in Section 1.2 above, a strength of our decomposition approach is that it facilitates, for any forecast variable, the ready identification of the factors that are most important in determining its forecast value. Not only should this focus discussions around sensitivity analysis, it should aid in the allocation of future research resources towards improving input values for those variables that have the largest influence on results for forecast variables of most interest to policy makers.

The remainder of this paper is structured as follows. Section 2 briefly discusses the theoretical structure of the VNET model, focusing on the modelling of the labour market. Section 3 discusses our forecasting approach and external forecasts and assumptions used in our forecasts. Section 4 analyses the contribution of each of the external forecasts on changes to the economy and to the labour market outcomes. This is important for understanding the forecasts, and for recognising ways in which the forecasts might be improved in future work. Section 5 concludes the paper.

2 THE MODEL

2.1 Introduction

The theory of the VNET model builds upon the theory of the ORANI-G model (Dixon *et al.*, 1982, Horridge 2003). It extends the labour market theory of ORANI-G through detailed modelling of markets for labour distinguished by occupation and educational attainment. At the same time, VNET contains accumulation equations that allow the model to be used to undertake long-run forecasting and policy simulations, not possible with ORANI-G. The major features of the model are described in the subsection below. The model is solved with the GEMPACK economic modelling software (Harrison and Pearson, 1996).

2.2 The ORANI-G core of the VNET theoretical structure

VNET has a theoretical structure which is typical of a static CGE model. It consists of equations describing, for some time period: producers' demands for produced inputs and primary factors; producers' supplies of commodities; demands for inputs to capital formation; household demands; export demands; government demands; the relationship of basic values to production costs and to purchasers' prices; market-clearing conditions for commodities and primary factors; and numerous macroeconomic variables and price indices.

Demand and supply equations for private-sector agents are derived from solutions to familiar optimisation problems underlying the behaviour of agents described in conventional neoclassical microeconomics. Each industry minimises unit costs subject to given input prices and a nested constant returns to scale production function. Three primary factors are identified (labour, capital and land) with labour further distinguished by occupation and qualification. Capital is assumed to be sector-specific, whereas labour is perfectly mobile among industries. Households are modelled as constrained maximizers of Klein-Rubin/Stone-Geary utility functions. Units of new industry-specific capital are cost-minimising combinations of Vietnamese and foreign commodities. For all commodity users, imperfect substitutability between imported and domestic varieties of each commodity is modelled using the Armington[5] constant elasticity of substitution (CES) assumption. The export demand for any given Vietnamese commodity is inversely related to its foreign-currency price. The model recognises consumption of commodities by government, and the details of direct and indirect taxation instruments. It is assumed that all sectors are competitive and all goods markets clear. Purchasers' prices differ from producer prices by the value of indirect taxes and trade and transport margins. The agents are assumed to be price-takers, with producers operating in competitive markets

[5] The name is used in honour of the author who first introduced the idea of imperfect substitutability between imported and domestically-produce goods via the linearised form of the CES input demand equations (Armington, 1969).

which prevent the earning of pure profits. For further details on the ORANI-G core of the VNET structure, we refer to the reader to Dixon *et al.*, (1982) and Horridge (2003).

2.3 Extensions in the theory of the VNET model

VNET contains four sets of equations not present in the ORANI-G model:

1. Equations describing details of the labour market distinguished by industry, occupation and qualification;
2. Equations calculating the solution year stock of persons holding each qualification;
3. Equations facilitating the calculation of solution-year net foreign liabilities; and
4. Equations to facilitate forecasting and decomposition simulations.

2.3.1 Modelling of the labour market

VNET contains detailed modeling of labour demand and supply, distinguished by 113 industries, 26 occupations and 6 qualifications. The industries, occupations and qualifications are listed in Appendix 1.

On the supply side, qualification holders allocate their labour across occupations so as to maximize their utility, subject to given occupational wages and a constraint on the total number of working hours available by each qualification. On the demand side, industries demand labour distinguished by occupation, choosing between different occupational types so as to minimize their labour costs, subject to given occupational wages and their overall demand for labour.

Figure 5 outlines the main relationships describing the supply and demand for labour distinguished by industry, occupation and qualification in the VNET model. The equations that describe the structure outlined in Figure 5 are, in percentage change form, as follows:

$$x_{o,s} = x_s^{(Q)} + \phi_{o,s}^{(Q)}[w_{o,s} - w_s^{(Q)}] \quad \text{(E4)}$$

$$x_{o,s} = x_o^{(O)} - \sigma_{o,s}^{(O)}[w_{o,s} - w_o^{(O)}] \quad \text{(E5)}$$

$$w_s^{(Q)} = \sum_{t \in OCC} \mathrm{S}_{t,s}^{(Q)*} \times w_{t,s} \quad \text{(E6)}$$

$$w_o^{(O)} = \sum_{\mathrm{t} \in \mathrm{SKILL}} \mathrm{S}_{o,t}^{(O)*} \times w_{o,t} \quad \text{(E7)}$$

$$\mathrm{H_o} \times x_o^{(O)} = \sum_{i \in IND} \mathrm{H_{i,o}} \times x_{i,o}^{(O)} \quad \text{(E8)}$$

$$x_{i,o}^{(O)} = x_i^{(I)} - \sigma_{i,o}^{(I)} \times [w_{i,o}^{(I)} - w_i^{(I)}] \quad \text{(E9)}$$

where:

$x_{o,s}$ is the percentage change in employment of occupation type *o* supplied by qualification *s*;

$x_s^{(Q)}$ is the percentage change in the number of hours of labour supply by qualification *s*. The solution year value for this is determined by (E11) discussed in Section 2.3.2 below.

$\phi_{(o,s)}^{(Q)}$ is the elasticity of supply to occupation type *o* by qualification type *s* in response to movements in the relative wage of occupation type *o*;

$w_{o,s}$ is the percentage change unit wage received by qualification type *s* when supplying labour to occupation type *o*;

$w_s^{(Q)}$ is the percentage change in the average wage received by qualification *s*;

$x_o^{(O)}$ is the percentage change in demand for occupation *o*;

$\sigma_{o,s}^{(O)}$ is the elasticity of substitution between labour supplied by different qualifications to occupation *o*;

$w_o^{(O)}$ is the percentage change in the average wage of occupation type *o*;

$S_{t,s}^{(Q)*}$ is CRESH weighted average share of qualification *s*'s total wage earnings earned in supplying labour to occupation *t*;

$S_{o,t}^{(O)*}$ is CRESH weighted average share of the total wages of occupation *o* represented by wages paid to qualification *t* supplying labour to occupation *o*;

H_o is total hours of employment in occupation *o*;

$H_{i,o}$ is total hours of employment of occupation *o* in industry *i*;

$x_{i,o}^{(O)}$ is the percentage change in employment of occupation *o* in industry *i*;

$x_i^{(I)}$ is the percentage change in employment in industry *i*;

$\sigma_{i,o}^{(I)}$ is industry *i*'s elasticity of substitution between different occupational types;

$w_{i,o}^{(I)}$ is the percentage change in the price of occupation *o* to industry *i*;

$w_i^{(I)}$ is percentage change in the price of labour to industry *i*;

The supply of qualification-specific labour enters the bottom level of Figure 5. At the bottom (fourth) level of Figure 5, labour distinguished by qualification is allocated across occupations on the basis of occupation-specific wage rates. Here, we assume that workers holding a given qualification allocate labour across occupations so as to solve the following problem:

Maximise: $U_s\left[X_{1,s}W_1, X_{2,s}W_2, \dots, X_{o,s}W_o\right]$ (E10)

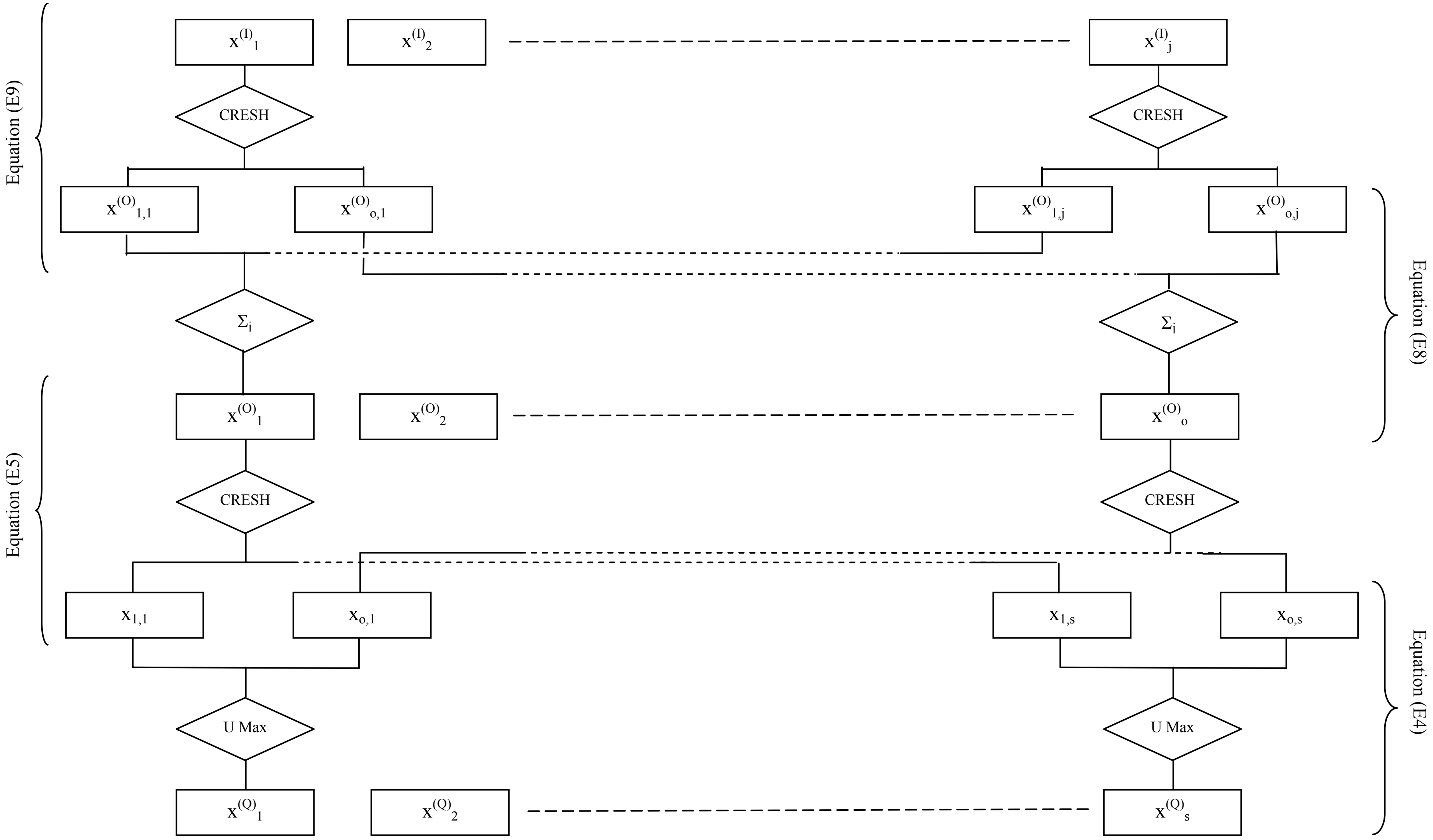
subject to: $X_s^{(Q)} = \sum_{o \in OCC} X_{o,s}$

In implementing this problem for VNET, we choose the CRESH functional form to describe U. As Dixon and Rimmer (2008) explain, (E10) describes a problem in which workers view wages earned in different occupations as imperfect substitutes. The utility maximising solution to (E10), converted to percentage change form, is (E4). Equation (E4) describes qualification-specific labour supply functions. In the absence of changes in relative wages, under equation (E4) expansion in supply of qualification *s* leads to uniform expansion in labour supply to all occupations to which qualification *s* supplies labour. A change in the wage of one occupation ($w_{o,s}$) relative to the average wage earned by qualification *s* ($w_s^{(Q)}$) induces transformation towards greater supply of labour to that occupation, with the strength of this substitution governed by the elasticity $\phi_{(o,s)}^{(Q)}$.

At the third level of Figure 5, units of occupation-specific labour are modelled as CRESH composites of occupation-specific labour distinguished by the skill supplying that labour. The percentage change form of the cost-minimising CRESH demand functions are described by equation (E5).[6]

[6] See Dixon *et al.* (1992: 126 – 128) for the derivation of percentage change demand functions from a CRESH function.

Figure 5: Disaggregated labour demand and labour supply



Together, equations (E4) and (E5) describe supply and demand functions for occupation- and qualification-specific labour ($x_{o,s}$). This requires wage rates for occupation- and qualification-specific labour ($w_{o,s}$) to be endogenous to clear these labour markets. Equations (E6) and (E7) calculate percentage changes in average wages by qualification ($w_s^{(Q)}$) and occupation ($w_o^{(O)}$) respectively, as the appropriate weighted sum of percentage changes in occupation- and qualification specific wage rates.

At the second level of Figure 5, economy-wide demand for labour of a specific occupational type is modelled as the sum of demands for that labour across all industries. This is described by equation (E8).

The top level of Figure 5 describes the conventional structure of ORANI-G labour demands by industry, with industry-specific labour demand modelled as a CRESH composite of labour distinguished by occupation. The industry-specific cost-minimising labour demands functions produced by this structure are described by equation (E9).

2.3.2 Equations to account for changes in the number of people holding particular qualification

The VNET database describes a solution to the model for the year *t*. A simulation with VNET is undertaken in two steps. First, the model is simulated with a set of shocks that update the model solution to a recent year, in this case, 2010. Second, the model is simulated with a set of shocks that represents a forecast out to some distant year, in this case, 2020. In each case, we require an equation to calculate the change in the number of people holding each of the qualifications in the model.

Here, we describe the equation governing the accumulation of qualifications across the forecast period. We begin by considering a forecast between the years 2010 and 2020. We assume that the number of persons holding qualification *s* in the year 2020, will be equal to:

(i) the number of persons who held qualification *s* in year 2010; less,

(ii) those who held qualification *s* in the year 2010, but who either permanently depart the workforce between 2011 and 2020 or retrain for another qualification; plus,

(iii) the number of people who acquire qualification *s* over the period 2011-2020; minus,

(iv) the number of newly-trained people holding qualification *s* who, either do not enter, or permanently depart, the labour force between 2011 and 2020.

More formally, the stock of persons holding qualification type *s* in the solution year $t + \tau$ is given by:

$$X_q^{(Q)t+\tau} = X_q^{(Q)t} \times (1 - r_q^{(1)})^{\tau} + \sum_{s=0}^{\tau-1} T_q^{t+s} (1 - r_q^{(2)})^{\tau-s-1} \qquad \text{(E11)}$$

where:

$X_q^{(Q)t}$ is the number of workers holding qualification type *q* in period *t*;

$r_q^{(1)}$ is the rate at which persons holding qualification type *q* at the start of the simulation period permanently leave the workforce or undertake training in a different qualification;

$r_q^{(2)}$ is the rate at which persons holding qualification type *q*, who join the workforce during the simulation period, permanently leave the workforce or undertake training in a different qualification;

T_q^s is number of people newly qualified with qualification type *q* who enter the labour force in period *s*.

A difficulty with equation (E11) is that it introduces a variable, T_q^s, describing numbers of people newly qualified with a particular skill in each of the years between t and t + τ. We offer the model user two options for the determination of training positions for the years between t and t + τ. The first option is to assume that training numbers grow smoothly between the years t and t + τ. The second option is to assume that training positions adjust in the year *t* + 1 to their t + τ value. The first option is implemented via:

$$\mathrm{T}_q^{t+s} = \mathrm{T}_q^t \left(\mathrm{T}_q^{t+\tau} / \mathrm{T}_q^t \right)^{s/\tau} \tag{E12}$$

Substituting (E12) into (E11) gives

$$\mathrm{X}_q^{(Q)t+\tau} = \mathrm{X}_q^{(Q)t}(1-\mathrm{r}_q^{(1)})^{\tau} + \sum_{s=0}^{\tau-1} \mathrm{T}_q^t \left(\mathrm{T}_q^{t+\tau} / \mathrm{T}_q^t \right)^{s/\tau} (1-\mathrm{r}_q^{(2)})^{\tau-s-1} \tag{E13}$$

The rationale for (E12) is the possibility of inertia in the process of adjustment of the number of annual training positions. Such inertia might reflect the time required to adjust training resources, such as teaching facilities and professional staff numbers, to changing student needs. However a potential problem with (E12) is that it may lead to over- or under-shooting of solution year training positions relative to long-run trend requirements in simulations in which solution year skill demands change significantly relative to the initial solution year. Apparent excessive adjustment of training positions can be reduced by assuming once-off year *t*+1 adjustment of training positions for skill *q* to its new level, a level that will be maintained over each year of the simulation period. This second option is implemented via:

$$\mathrm{T}_q^{t+s} = \mathrm{T}_q^{t+\tau} \qquad (s = t+1 \ldots \tau) \tag{E14}$$

Substituting (E14) into (E11) provides:

$$\mathrm{X}_q^{(Q)t+\tau} = \mathrm{X}_q^{(Q)t} \times (1-\mathrm{r}_q^{(1)})^{\tau} + \sum_{s=0}^{\tau-1} \mathrm{T}_q^{t+\tau} (1-\mathrm{r}_q^{(2)})^{\tau-s-1} \tag{E15}$$

Equations (E13) and (E15) can together be written as:

$$\mathrm{X}_q^{(Q)t+\tau} = \mathrm{X}_q^{(Q)t}(1-\mathrm{r}_q^{(1)})^{\tau} + \sum_{s=1}^{\tau-1} \mathrm{T}_q^t \left(\mathrm{T}_q^{t+\tau} / \mathrm{T}_q^t \right)^{(1+D(s/\tau-1))} (1-\mathrm{r}_q^{(2)})^{(\tau-s-1)} + \mathrm{T}_q^t (1-\mathrm{r}_q^{(2)})^{(\tau-1)} \tag{E16}$$

Equation (E16) introduces the dummy variable D. With D equal to 0, equation (E16) becomes (E15). With D equal to 1, equation (E16) becomes equation (E13).

2.3.3 Equations to facilitate calculation of adjustment to qualification acquisition shares

In the forecast simulation, we allow the model to calculate the changes in qualification acquisition shares necessary to maintain initial wage relativities. In the decomposition simulation, the forecast changes in qualification acquisition shares are imposed as exogenous shocks. To facilitate and implement the calculation of these shocks, we highlight equations (E17) – (E20) of the VNET model:

$$t_s = s_s^{(Q)} + t^{(Q)} \tag{E17}$$

$$ss = \sum_s S_s^{(Q)} s_s^{(Q)} \tag{E18}$$

$$w_s^{(Q)} = \xi^{(3)} + f_s^{(Q)} + f^{(Q)} \tag{E19}$$

$$L\,l = \sum_q X_q^{(Q)} x_q^{(Q)} \tag{E20}$$

where

$S_s^{(Q)}$ is a coefficient measuring the level of the qualification acquisition share, that is, the proportion of those entering the workforce (or re-entering the workforce after training) who possess qualification type s,

L is the level of economy-wide employment measured in persons;

$X_q^{(Q)}$ is the level of the number of persons holding qualification type q;

and where the remaining variables of equations (E17) – (E20) are explained in Table 2. Table 2 also describes the closure of these variables under the forecasting and decomposition simulations.

Table 2. Variables and model closure pertaining to adjustment of qualification acquisition shares in forecasting and decomposition simulations

Variable	Description	Forecast	Decomp
t_s	The percentage change in the number of people entering the workforce who have newly acquired qualification *s*. This is the percentage change form of the variable $T_q^{t+\tau}$, which appears in equation (E16).	N	N
$t^{(Q)}$	The percentage change in the total annual number of people entering the workforce (or re-entering the workforce after training).	N	X
$s_s^{(Q)}$	The percentage change in the qualification acquisition share, measuring the proportion of those entering the workforce (or re-entering the workforce after training) who possess qualification type s;	N	X
ss	The share weighted sum of the percentage changes in qualification acquisition shares.	X	N
$w_s^{(Q)}$	The percentage change in the average wage received by qualification *s*;	N	N
$\xi^{(3)}$	The percentage change in the consumer price index	X	X
$f_s^{(Q)}$	A qualification-specific shifter on the real wage received by qualification *s*;	X	N
$f^{(Q)}$	A general shifter on the real wage received by all qualifications	N	X
$x_q^{(Q)}$	The percentage change in the number of persons holding qualification type q (determined by equation E17 above).	N	N
l	The percentage change in economy-wide employment measured in persons.	X	N

In the decomposition simulation, aggregate employment is endogenous, and determined by equation (E20) as the share weighted sum of the percentage changes in qualification-specific employment, $x_q^{(Q)}$. Qualification-specific employment ($x_q^{(Q)}$) is determined by equation (E16). As discussed in

Section 2.3.2, the chief determinant in equation (E16) of the movement in the number of people with qualification q is movement in the number of people trained in qualification q. The percentage change in annual training in qualification q is determined by equation (E17) above. As is clear from Table 2, in the decomposition simulation, both the aggregate number of annual entrants to the workforce each year ($t^{(Q)}$) and their qualification acquisition propensities ($s_s^{(Q)}$) are exogenous during the decomposition simulation, and shocked equal to their forecast simulation values. In the forecast simulation, both these variables are determined endogenously, with their values effectively determined by the exogenous status of aggregate employment (*l*) and qualification-specific wage relativities ($f_s^{(Q)}$).

2.3.4 Accounting for changes in net foreign liabilities over the forecast period.

We include in VNET an equation that calculates net foreign liability accumulation over the forecast period. This equation is based on the MONASH model equation that performs the same net debt accumulation function, as described in Dixon and Rimmer (2002:43-47). Here, we present equation (E21) as a stylised representation of the VNET equation that calculates accumulation of net foreign liabilities over the simulation period:

$$NFL_{t+\tau} = NFL_t + \sum_{s=0}^{\tau-1}[K_{t+s+1} - K_{t+s}(1-D)] - \sum_{s=0}^{\tau-1}[(1-APC_{t+s})\cdot GNP_{t+s}] \quad \text{(E21)}$$

where

t	is the initial year (say, 2010);
τ	is the solution year (say, 2020);
$NFL_{t+\tau}$	is net foreign liabilities in the solution year;
NFL_t	is net foreign liabilities in the initial year;
K_{t+s}	is the capital stock in the year $t + s$;
APC_{t+s}	is the national average propensity to save in year $t + s$;
GNP_{t+s}	is gross national product in year $t + s$; and
D	is the rate of depreciation.

In understanding equation (E21), it is helpful to see that the level of net foreign liabilities in the solution year can be divided into three components:

i. the initial level of net foreign liabilities, NFL_t;

ii. the gross addition to net foreign liabilities between the initial solution year and the final solution year required to finance accumulated investment over the period: $\sum_{s=0}^{\tau-1}[K_{t+s+1} - K_{t+s}(1-D)]$; and

iii. the gross reduction in net foreign liabilities between the initial solution year and the final solution year due to accumulated savings: $\sum_{s=0}^{\tau-1}[(1-APC_{t+s})\cdot GNP_{t+s}]$.

2.3.5 Equations to accommodate external forecasts for changes in preferences,

In forecasting, it is convenient to endogenise twist variables to accommodate external forecasts for variables such as import volumes and labour or capital prices.[7] The import twist, for example, allows an exogenously specified rate of aggregate import growth to be accommodated by the model via a cost neutral change in import/domestic quantity shares across all users of imports. In the example that

[7] See Dixon and Rimmer (2002: 202-204).

follows, we focus on the equations governing the import/domestic twist terms. The same basic theory applies to the derivation of twists relating to labour and capital demands

The cost-neutral twists can be interpreted as domestic- and import-using technical changes. The relationship between the twist variable and source-specific technical change is expanded upon below. This relationship is important in forecasting and decomposition analysis. In forecasting, we typically endogenise the twist terms in order to accommodate external forecasts for import volumes. Via equations (E26) and (E27) below, the required cost-neutral movements in underlying technical change are endogenously calculated. However in decomposition simulations, the twists are endogenous, and instead the technical change variables are exogenous and given their forecast values. This ensures that the technical and taste changes (rather than the twists) are the same in the decomposition and forecast simulations.[8]

The derivation of twist-related technical and taste changes is expanded upon below in the context of import-domestic twists. In this case, we can present the twist problem as one of finding the values of small changes in technology a_d and a_m used in combining commodity *c* from domestic (d) and imported (m) sources so that there is no change in the cost of compiling good *c* and a target change in the import / domestic ratio (*t*) is met:

$$S_d a_d + S_m a_m = 0 \text{, and} \tag{E22}$$

$$x_m - x_d = t \tag{E23}$$

where
- S_d and S_m are the shares of domestic and imported goods in the composite commodity;
- a_d and a_m are the percentage changes in technology of using domestic and imported commodities *c*;
- x_m and x_d are the percentage changes in the demands for imported and domestic good *c*; and
- *t* is the twist term.

From the demand function for source-specific commodities arising from a CES production function (see, for example, Dixon *et al.* 1992: 124 - 126), we can see that if there are no changes in relative prices, demand for imported and domestically-produced variety of the good *c* will be:

$$x_m = x + a_m - \sigma(a_m - \sum_{t \in SRC} S_t a_t) \tag{E24}$$

$$x_d = x + a_d - \sigma(a_d - \sum_{t \in SRC} S_t a_t) \tag{E25}$$

Substituting (E24) and (E25) into (E23), and then solving the simultaneous system of equations with (E22) gives:

---

[8] This distinction is more important in policy simulations than decomposition simulations. A policy simulation is like the decomposition simulation, except that values for certain exogenous variables (namely, those describing a policy change relative to basecase) differ from their forecast values. If we exogenise the twists in the policy simulations, then we impart different technical changes in the policy simulation than in the forecast simulation. This is because the policy shocks cause import/domestic shares in the policy simulation to differ from their values in the forecast simulation. As Dixon and Rimmer (2002) describe, with different technical changes in the policy simulation relative to the forecast simulation, interpretation of the policy results becomes difficult.

$$a_d = [S_m / (\sigma - 1)] t \qquad \text{(E26)}$$

$$a_m = -[S_d / (\sigma - 1)] t \qquad \text{(E27)}$$

These equations form the basis for the twist equations described in the VNET model.

2.3.6 Neutralisation of the cost impacts of commodity-using technical change

Commodity-using bias in technical change is described in ORANI-G and VNET by a_c. In forecasting simulations, exogenous shocks are imparted to the elements of a_c reflecting secular trends in commodity-using technical change. However, in forecasting, we would not normally want the movements in the a_c's to affect per-unit production costs or per-unit capital formation costs. The effects of a_c in industries' and investors' costs are neutralised by introducing variables $a_i^{(1)}$ and $a_i^{(2)}$ which represent the cost-offsetting changes in all inputs by industries and investments per unit of outputs. They are calculated according to the following formulas:

$$a_i^{(1)} = -\sum_{c \in COM} \sum_{s \in SRC} S_{c,s,i}^{(1)} a_c \qquad \text{(E28)}$$

$$a_i^{(2)} = -\sum_{c \in COM} \sum_{s \in SRC} S_{c,s,i}^{(2)} a_c \qquad \text{(E29)}$$

where $S_{c,s,i}^{u}$ is the share of purchasers' values of commodity *c* from source *s* to industry/investor *i* in total output values of industry/investor *i*.

2.3.7 Occupation-specific bias in labour productivity

In our forecasting simulations, we wish to allow for secular technology-driven trends in the occupational composition of the workforce. For example, one of the effects of growing use of computers in the workplace has been a reduction in the need for intermediate clerical, sales and service occupations, and a growth in the need for mid-level professional occupations. We construe these shifts in the occupational composition of the workforce in terms of cost-neutral occupation-specific bias in labour-using technical change. Henceforth, we refer to these changes as "occupational twists".

The derivation of occupational twists is described below. The problem is to find the values of the small changes in occupation-specific input requirements in labour demand ($a_1, a_2, ...a_n$) that leaves the effective cost of labour inputs to production unchanged, while at the same time achieving a target movement in the ratio *t* between employment in a given occupation and employment in a particular reference occupation. Any occupation can be chosen as the reference occupation, and in this derivation below we choose occupation 1.

More formally, the problem is to find $a_1, a_2, ...a_n$ so that:

$$S_1 a_1 + S_2 a_2 + ... + S_n a_n = 0 \text{, and} \qquad \text{(E30)}$$

$$x_2 - x_1 = t_2 \qquad \text{(E31)}$$

$$x_3 - x_1 = t_3 \qquad \text{(E32)}$$

....

$$x_n - x_1 = t_n \qquad \text{(E33)}$$

where

- S_1 to S_n are the cost shares of occupations 1 to n in an industry's labour use;
- a_1 to a_n are the percentage changes in technology of using occupations 1 to n in each industry, defined as the quantity of occupation *n* required per unit of effective input of occupation *n*;
- x_1 to x_n are the percentage changes in the demands for occupations 1 to n in each industry; and
- t_2 to t_n are the occupational twists of occupations 2 to n relative to occupation 1.

In VNET, an industry's demand function for occupation-specific labour arising from a CES production function is:[9]

$$x_o = x + a_o - \sigma(p_o + a_o - p) \quad \text{(E34)}$$

where

- x_o is the percentage change in the demand for occupation o;
- x is the percentage change in the demand for labour, undistinguished by occupation;
- σ is the elasticity of substitution between occupations;
- a_o is occupation –o- using technical change;
- p_o is percentage change in the price of occupation o; and
- p is percentage change in the price of a composite labour unit.

We can see from (E34) that if there are no changes in relative prices, demand for occupation *n* in each industry will be:

$$x_1 = x + (1-\sigma)a_1 \quad \text{(E35)}$$
$$x_2 = x + (1-\sigma)a_2 \quad \text{(E36)}$$

....

$$x_n = x + (1-\sigma)a_n \quad \text{(E37)}$$

Substituting (E35) - (E37) into (E31) – (E33), and then solving the simultaneous system of equations with (E30) gives:

$$a_2 = a_1 + \frac{t_2}{1-\sigma} \quad \text{(E38)}$$

....

$$a_n = a_1 + \frac{t_n}{1-\sigma} \quad \text{(E39)}$$

and $a_1 = -\left(\frac{1}{1-\sigma}\right)\sum_{k=2}^{n} S_k t_k$ (E40)

[9] see, for example, Dixon et al. 1992: 124 – 126.

3 FORECASTING THE LABOUR MARKET CONSEQUENCES OF STRUCTURAL CHANGES IN THE VIETNAMESE ECONOMY, 2011-2020

3.1 Forecasting approach

A typical simulation with VNET is undertaken in two steps. First, the model is simulated with a set of shocks that updates the model's solution to a recent year, such as 2010. Second, the model is simulated with a set of shocks that represents a forecast out to some distant year, such as 2020.

The process can be illustrated diagrammatically as in Figure 6, where $\overline{V}(t)$ is the initial solution for year t, and V(t) is the required solution for year t.

We begin with a model calibrated on data for 2005. This represents our initial solution to the VNET system of equations. To conduct a forecast for the period 2011-2020, we must begin by updating the model solution to the year 2010. We do this by moving the model's exogenous variables from their 2005 values to their 2010 values. We then simulate the model with a set of shocks that represents a forecast out to some distant year, such as 2020.

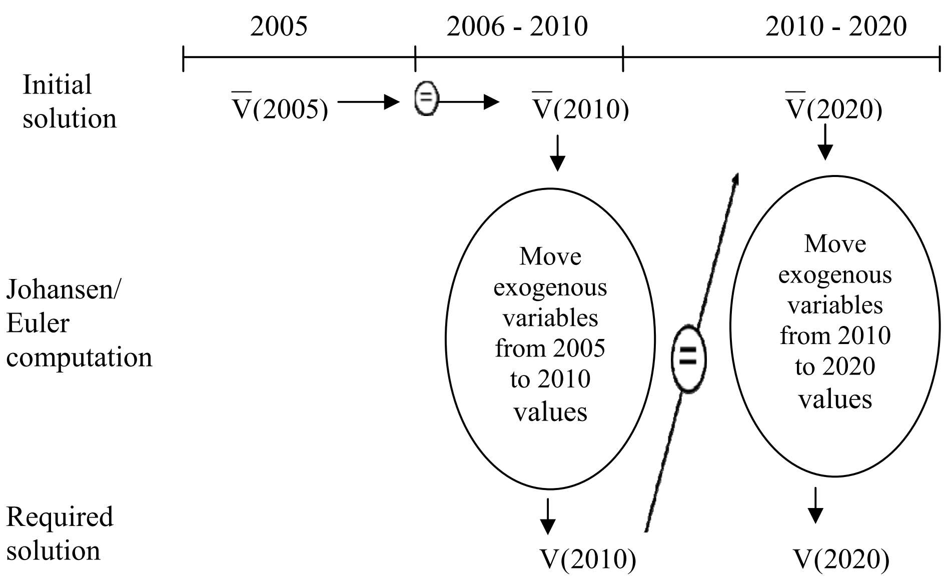


Figure 6: A sequence of solutions in VNET forecasting
(adapted from Dixon and Rimmer 2002:129)

3.2 Updating the model from 2005 to 2010

The VNET model database is compiled from the input-output table for Vietnam for the year 2005 (GSO 2008b). To update the model so that it describes the structure of the economy in 2010, we shock the model with observed changes in economic variables over the period 2006-2010. We impose shocks to variables that are normally endogenous (thus requiring endogenous determination of appropriate structural variables) and variables that are naturally exogenous. In the former category, we include: real GDP (with primary factor productivity determined endogenously), real private consumption (with the average propensity to consume determined endogenously), real public consumption (with the ratio of public to private consumption spending determined endogenously). In the latter category, we include: population growth, employment growth (GSO, 2011a, 2011b), and changes in agricultural land use (NIAPP, 2010). At the sectoral level, we extrapolate historical trends in changes in production technology and household consumption preferences. This updating simulation provides us with a solution to the model for the year 2010, which serves as an initial solution in our Johansen/Euler computation for the year 2020. The structure of the economy and the structure of the labour force in the year 2010 are helpful in understanding the forecast results for 2020. Hence, we provide tables describing industry and employment structures for the economy in 2010 in Appendixes 2 and 3.

3.3 Exogenous forecasts and assumptions for the economy during the 2011-2020 period

3.3.1 Independent macro forecasts for real GDP, employment and population

We impose on the model the independent forecasts for real GDP, population and employment. We impose a GDP forecast of 7.3 per cent per annum over the period, based on IMF/WB (2010. Population and employment are forecast by ILSSA to grow by 1.04 and 1.39 per cent per annum over the period.

3.3.2 Macroeconomic assumptions governing aggregate consumption

We assume that aggregate consumption spending (private and public) is a fixed proportion of national income. We assume that this propensity to consume out of national income will be unchanged over the forecast period. This assumption effectively determines aggregate consumption spending. However, we allow the ratio of public to private consumption spending to change. A stylised fact of economic growth is that the elasticity of public consumption spending to real GDP is slightly higher than 1. In our forecast simulation, we index the percentage change in public consumption spending to the percentage change in real GDP with an elasticity of 1.1. This elasticity value is based on an estimate for ten Asian developing countries reported in Akitoby *et al.* (2006).

3.3.3 Macroeconomic assumptions governing the capital stock and investment

We assume that because our forecast period is relatively long, investors in each industry will have sufficient time to adjust industry capital stocks in response to forecast changes in the economy. Thus changes in demand for capital will manifest as changes in capital supply, not as changes in rental rates. We implement this by allowing capital to be in elastic supply to each industry at exogenous rates of return.

We assume that the desired rate of capital accumulation in each industry in the 2020 solution year will be independent of the forecast changes in structure, policy and foreign trading environment. We implement this via exogenous determination of industry investment/capital ratios. With movements in long-run industry capital stocks largely determined by the closure assumption outlined in the preceding paragraph, this effectively links long-run movements in industry investment to movements in industry capital stocks. National investment is determined as the sum of industry-specific investments.

Giesecke and Tran (2009) found capital bias in technical change in the past development of the Vietnamese economy. We assume that this bias towards greater use of capital relative to labour (for a given wage/rental ratio) will continue over the forecast period.

3.3.4 Changes in international trade

The high GDP growth rate for Vietnam implies that, *ceteris paribus*, Vietnamese export volumes will grow. In the absence of expansion in foreign demand for Vietnam's exports, growth in Vietnam's export volumes will cause Vietnam's terms of trade to decline. Trade is a high share of Vietnamese GDP, so movements in the terms of trade have important consequences for national income and real consumption. We assume that foreign demand for Vietnamese exports will expand enough to cause the terms of trade to stay unchanged over the forecast period. We think this is a realistic assumption, for three reasons. First, as Vietnam grows, other economies will also grow, shifting outwards demand curves for Vietnamese exports. Second, as Vietnam develops, we expect Vietnamese trade negotiators will have growing success in accessing foreign markets and countering protectionist reactions to export expansion. Thirdly, Vietnamese entrepreneurs will have success in developing new products and niche markets for their exports. In the forecast simulation, we implement this scenario by holding the terms of trade unchanged via endogenous determination of a commodity-wide export demand shift. Under this environment, as the Vietnamese economy grows, foreign demand schedules for Vietnamese exports shift outwards, thus accommodating expansion in Vietnamese exports at given foreign currency export prices.

We adjust the Vietnamese 'openness ratio', defined as the ratio of the value of trade (exports plus imports) to nominal GDP. Empirical cross-country studies have found a robust negative relationship between country size and openness. Using the Penn World Table data, version 6.1, for more than a hundred economies, Alesina *et al.* (2005) found a correlation coefficient of -0.334 between the openness ratio and the log of GDP. Using this coefficient, we might expect Vietnam's openness ratio to decline from its value of 1.3 in 2005 to about 1.2 by 2020. In the forecast simulation we exogenously determine the openness ratio via endogenous determination of cost-neutral import / domestic bias in technical change. As we reduce Vietnam's openness ratio over the forecast period, the propensity to import declines. Since our macro closure links consumption with national income, there is little potential for the ratio of the balance of trade to GDP to change through time. Hence, with the import share in GDP declining, so too does the export share in GDP.

Our forecast also includes our estimates of Vietnam's WTO tariff reductions, based on the country's WTO commitments (WTO, 2007). Under these commitments, the largest tariff reductions occurred in 2007, and all tariff cuts are to be completed by 2014. Therefore, the forecast tariff reductions are small for the period 2011-2020. For this period, the largest tariff cuts are for motor vehicles, alcohol beverages, leather products, and home appliances. Smaller cuts are forecast for many other manufactured products, such as food stuffs, tobacco products, chemical products, machinery and equipment.

3.3.5 Industry technical changes

The high growth rate of GDP, at a given population and employment growth rate, and relatively stable capital-labour ratio, must mean that there will be high level of technical improvement in the economy. In our simulations, we impose the growth rate of GDP and other known factors on the economy, and the model calculates the required level of technical change for the whole economy.

However, technical changes may not be the same for all industries. To make assumptions about industry-specific technical change in addition to economy-wide technical change, we use results from a historical analysis by Giesecke and Tran (2009), which investigated, among other things, changes in industry primary factor augmenting technology and input-using technology in Vietnam for the period

1996-2003. During that period, most industries experienced technical improvement. Industries with the largest technological progress included financial services, mining, agriculture, food processing industry, public administration and many other services. There were some industries which experienced technical regress, such as construction, trade and repair services. For some agricultural industries, such as paddy rice, sugarcane, and fish farming, we have time series data on their area and output (GSO 2011c). From these data we calculated technical changes to these industries, and adopt them for the year 2010.

For the forecast period, we assume that industries with technical improvement in the past will have above average technical improvement, and industries with technical regress in the past will only have average technical change. Our assumptions for industry-specific annual average technical changes for the period 2011-2020 for 20 aggregate industries are reported in column 1, Table A5.1, Appendix 5.

3.3.6 Changes in the commodity-composition of intermediate input usage

Our forecast allows for changes in the composition of industry intermediate input usage. Shifts in intermediate input usage are likely to be driven by a number of factors. For example, it is generally believed that changes in material-using technology and increases in efficiency are driving firms to tend to use fewer primary materials (such as lead, steel, copper, timber) and more light and artificially structured materials (such as plastic, aluminium, chemicals, and paper) (Wernic *et al.* 1996). Other observers have noted a trend towards greater use of services, as more activities once undertaken within the firm are out-sourced.

For our forecasting simulation, our assumptions about the pattern of these changes are based on Giesecke and Tran (2009). They found intermediate input requirements for most machinery and equipment inputs rising. So too did building materials, and many other manufactured products and services. Intermediate input requirements for tobacco products, bicycles, trade, repairs, public administration, culture and sport, some land transport services, and raw agricultural products decreased. We adjust these changes based on our observations of trends in production technologies in Vietnam and elsewhere (as discussed in Wernic *et al.* 1996, for example), and changes in the degree of outsourcing in the economy. We then reduce these numbers at the rate of 5 per cent per annum in each year of the simulation period. The annual average technical changes for 20 aggregate commodities are reported in column 2, Table A5.1, Appendix 5.

3.3.7 Household taste changes

As Vietnam develops, we expect that household tastes will change. Studies in economic growth have shown that typically, as income increases, household consumption moves away from food items and towards manufacturing and services (Syrquin, 1989, p. 231). For Vietnam, we see this pattern confirmed, both via inspection of consumption shares across the ten household types, distinguished by rural/urban area and expenditure quintile, in Vietnam Living Standard Survey 2004 (GSO 2006), and via historical simulation with a large-scale CGE model of Vietnam undertaken by Giesecke and Tran (2009). The latter found that in the last decade there were shifts toward services (such as tourism, transport and communication, financial services, education, utilities, entertainment, and insurance), and manufacturing products (such as mobile phones, DVDs, personal computers, household appliances, motor vehicles, and personal hygiene and cosmetic products). Consumers have also become more health-conscious, with the result that demands increased for pharmaceuticals, as well as for dairy and non-alcoholic beverages, but decreased for tobacco products. Dairy products were not one of the traditional foods for the Vietnamese people, but now the dairy sector is one of the fastest growing sectors in Vietnam's packaged food category. Household tastes shifted away from primary commodities (such as agriculture, mining and metal products), as people consume more processed and manufactured goods rather than producing those goods themselves. There was also a shift away from repair services, reflecting a propensity to replace rather than repair household appliances and vehicles as real incomes rise. We adopt these changes for the year 2005, and assume that they will diminish over time at the rate of 5 per cent per annum in each year of the update and forecast. The annual average household taste changes for 20 aggregate commodities are reported in column 3, Table A5.1, Appendix 5.

3.3.8 Changes in the occupational structure of the workforce

As discussed in Section 2.3.7, changes in technology may induce changes in industry preferences for occupations. That is, industries may employ more of one occupation compared with another occupation, even if there are no changes in the relative wage rates of these occupations.

In order to inform our assumptions about changes in occupation-specific input demand in the forecast period, we calculated occupational twists for the period 2004-2008. We calculated changes in employment by occupation x_o, occupational wages p_o, and changes in industry employment x during the period 2004-2008, using data from VHLSS 2004, VHLSS2006 and VHLSS2008. We then calculated occupation-specific twists using (E34), and (E38) - (E40), with unskilled workers as our reference occupation.

We report the historical movements in occupation-specific twist variables in Table A5.2, Appendix 5. In general, our results show a bias in technical change away from unskilled workers and elementary professionals and technical personnel; and towards skilled handicraftsmen and high-level professionals. Since our calculation of occupation-specific bias in technical change covers the period 2004-2008, we adopt the results from our calculation of this bias for the first three years of our update simulation (2005-2008), and then, similar to changes to technology and tastes, we assume that the bias in occupation-specific technical change will diminish at the rate of 5 per cent per annum

3.3.9 Changes in agricultural land

We have data from National Institute of Agricultural Planning and Projection (NIAPP, 2010), for the planned areas for agricultural land in general, and paddy land in particular. NIAPP (2010) also includes data on the areas expected to be submerged under the sea due to climate change, if the sea level rises by 12 cm by 2020. The data show that the reduction of agricultural land and paddy land will be 3.8 per cent and 10.7 per cent respectively. The detailed data and our calculation of changes for the agricultural land are reported in Table A5.3, Appendix 5.

3.3.10 Training policy

We assume that Vietnam’s educational institutions will be sufficiently flexible that they can adjust qualification attainment rates over the forecast period so as to keep relative wage rates across qualifications unchanged from their 2010 relativities. The model mechanisms that achieve this are discussed in Section 2.3.2 above.

4 DECOMPOSITION SIMULATION: IDENTIFYING THE SOURCES OF GROWTH AND STRUCTURAL CHANGE IN THE VIETNAMESE LABOUR MARKET

In this section, we discuss our forecast results in detail, relying on the decomposition simulation to elucidate the individual impacts of our forecast changes in many variables describing structural, policy and external features of the Vietnamese economy. Indeed, our forecast simulation is effectively comprised of shocks to hundreds of VNET variables, and so reporting results necessarily requires some summarisation. This is done by aggregating the individual effects of each of the exogenous shocks within 11 sets of related variables. These 11 sets correspond to the first 11 columns of the tables. Results in any given column can be interpreted as the impact of the forecast movements of the exogenous variables in question (e.g. technical change in column 1) in isolation of the exogenous structural and policy shocks represented by the other columns.[10] Results in any given row show the individual contributions of the 11 exogenous factors to the forecast movement of the endogenous variable in question. Hence, inspection across rows provides explanations for economic outcomes in terms of contributions by structural and policy change. For example, strong GDP growth (row 1) is due largely to productivity growth (column 1) and the increase in aggregate employment (column 2). The remainder of this section interprets the results in Tables 3 - 9, proceeding column by column.

4.1 Technical change (Column 1)

Column 1, Table 3, isolates the economic effects of forecast changes in variables describing input-using technical change. The column aggregates the effects of a large number of technical changes, including: primary factor productivity, distinguished by industry; commodity-specific input-using technical change; all-input-using technical change in both current production and capital formation, distinguished by industry; and, economy-wide labour/capital bias in technical change. In aggregate, these changes in industry-specific and commodity-specific technology variables represented a rise in total factor productivity of 37.1 per cent. This accounts for much of the forecast rise in real GDP to 2020.

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[10] The Harrison et al. (2000) decomposition algorithm calculates an exogenous variable's contribution to the total outcome for a given endogenous variable by summing its contributions as it moves along a path from its pre- to post-shock value. This requires, along this path, continuous re-evaluations of the endogenous variable's elasticity to the exogenous variable in question. These elasticities will be somewhat dependent on movements in other shocked variables. Hence, the effects of a given shock in a given column are largely, but not completely, independent of shocks in other columns.

Table 3. Decomposition results, macro variables, 2011-2020 *(percentage change, unless otherwise stated)*

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Variables	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	Total	Annual average
	Nature of exogenous shifts	DS	DF	F	DS	DP	DS	DS	DF	DP	DP	F		
1	Real GDP	60.7	18.0	10.3	6.0	5.8	0.5	1.9	-0.5	-0.8	0.1	0.7	102.9	7.3
2	Real GNP	47.5	14.4	21.3	3.9	4.5	0.2	3.1	-0.6	-0.6	-0.1	4.3	97.9	7.1
3	Real private consumption	46.9	14.2	21.1	3.8	4.4	0.2	3.0	-0.5	-3.7	-0.1	4.2	93.7	6.8
4	Real public consumption	50.3	15.1	22.5	4.1	4.7	0.2	3.3	-0.6	13.5	-0.1	4.5	117.6	8.1
5	Real investment	45.4	15.2	23.3	5.9	5.0	1.1	4.7	-0.2	-0.9	0.1	1.5	101.1	7.2
6	Real exports	84.7	22.2	19.6	8.5	7.3	1.8	-12.9	0.2	-1.0	0.6	-4.1	126.9	8.5
7	Real imports	58.6	16.2	34.4	6.0	5.2	1.4	-6.4	0.1	-0.9	0.4	0.9	115.8	8.0
8	Aggregate employment, persons	0.0	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.8	1.4
9	Aggregate employment, hours weighted	-0.0	16.4	-0.0	0.0	3.1	0.0	-0.0	0.0	0.0	-0.0	-0.0	19.5	1.8
10	Aggregate employment, wage weighted	0.2	20.2	-0.3	6.8	6.4	0.3	-0.1	0.1	-0.2	0.0	-0.1	33.3	2.9
11	Aggregate capital stock	44.5	15.5	22.8	5.5	5.3	0.8	4.4	-0.2	-1.2	0.1	1.4	98.8	7.1
12	Aggregate land use	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.3	0.0	0.0	0.0	-3.3	-0.3
13	GDP price deflator	-5.6	-3.5	9.6	-0.2	-1.8	0.2	1.5	-0.1	0.4	-0.1	0.5	0.8	0.1
14	Price deflator for consumption[11]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Investment price index	6.3	1.0	-4.5	0.4	-0.4	0.7	-0.5	-0.3	0.1	-0.0	-0.3	2.3	0.2
16	Real wage, CPI deflated	35.1	-16.5	32.6	-2.9	-6.4	0.8	6.5	-1.4	1.5	0.2	2.1	51.8	4.3
17	Average rental price of capital	6.3	1.0	-4.7	0.4	-0.4	0.7	-0.6	-0.3	0.1	-0.0	-0.3	2.3	0.2
18	Real exchange rate[12]	-20.4	-7.8	24.7	-2.0	-3.2	-0.5	3.9	-0.1	0.5	-0.2	1.5	-3.5	-0.4
19	Terms of trade	-10.0	-2.8	12.7	-1.1	-0.9	-0.3	1.6	0.0	0.1	-0.1	0.5	-0.1	-0.0
20	Change in NFL/GDP ratio	0.4	0.2	0.2	0.1	0.1	0.0	0.0	0.0	-0.0	0.0	-0.5	0.5	0.1

[11] In this simulation, the CPI is the numeraire, and hence is kept unchanged. All other prices are reported as a deviation away from the CPI.

[12] Defined as the ratio of domestic to foreign price levels. Hence a positive change in real exchange rate means an appreciation of the domestic currency.

Table 4. Decomposition results of output for 20 aggregate sectors, 2011-2020 *(percentage change)*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Sector	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	Total	Annual average
Nature of exogenous shifts	DS	DF	F	DS	DP	DS	DS	DF	DP	DP	F		
1. Agriculture and forestry	59.2	10.7	-6.3	10.9	0.1	-4.2	-1.5	-4.0	-0.6	0.0	-0.4	64.0	5.1
2. Fishery	63.1	15.1	0.5	6.2	3.4	3.1	-3.6	0.6	-1.4	0.2	-0.7	86.4	6.4
3. Mining	75.4	11.2	-6.0	-1.7	5.9	-0.4	-3.0	0.4	-0.9	0.1	-1.3	79.8	6.0
4. Food, beverage and tobacco products	62.1	15.4	1.2	8.4	3.0	-3.9	1.6	-1.1	-1.9	0.0	0.6	85.4	6.4
5. Non-metal products	88.5	24.7	5.4	10.0	8.2	0.6	6.9	0.2	-1.2	0.2	-0.2	143.3	9.3
6. Metals, machines and equipment	100.0	36.7	11.8	9.3	17.4	1.9	9.5	1.2	-3.0	-0.4	-2.9	181.5	10.9
7. Chemicals	98.3	33.8	2.5	6.3	12.5	5.8	14.9	0.3	-3.3	-0.2	-1.0	169.9	10.4
8. Textile, clothing and footwear	91.7	27.4	42.1	10.9	6.7	-0.2	-4.4	2.0	-1.1	0.8	-4.1	171.7	10.5
9. Other manufacturing products	95.8	29.0	17.5	12.2	9.7	1.0	6.5	0.8	-0.9	0.1	-0.6	171.2	10.5
10. Gas, electricity and water	93.2	25.6	12.3	7.5	9.1	2.1	5.1	0.2	-1.6	0.1	-0.3	153.2	9.7
11. Construction	35.7	12.7	23.1	6.3	4.1	1.1	4.4	-0.3	-0.5	0.1	2.1	88.8	6.6
12. Trade and repair	52.4	19.1	25.3	5.9	6.3	1.7	0.2	-0.1	-2.3	0.2	0.9	109.8	7.7
13. Hotels and restaurants	73.1	24.8	1.5	9.4	6.9	10.8	0.7	0.5	-2.5	0.0	0.8	126.0	8.5
14. Transport and communications	70.0	22.4	12.9	5.8	8.3	7.4	2.8	-0.2	-1.8	0.1	1.1	128.6	8.6
15. Financial services	118.7	40.9	0.2	1.1	16.5	10.4	12.4	0.5	-3.5	0.2	0.5	197.5	11.5
16. Property and business services	80.9	26.9	12.2	2.7	9.9	0.5	1.3	0.2	-0.2	0.1	0.7	135.3	8.9
17. Public administration	49.3	16.2	21.2	3.7	5.2	0.2	3.0	-0.5	13.3	-0.1	4.4	115.8	8.0
18. Education	58.5	21.4	14.7	3.1	8.0	0.9	2.9	-0.3	9.0	-0.0	3.3	121.5	8.3
19. Health care	56.8	24.5	11.1	2.0	9.8	2.8	3.1	-0.1	2.7	-0.0	2.7	115.4	8.0
20. Other services	68.6	17.7	18.0	6.8	6.1	-1.1	3.6	-0.1	-3.3	-0.1	3.9	120.1	8.2

Table 5. Decomposition results for industry employment by 20 aggregate sectors, 2011-2020 *(percentage change)*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Sector	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	Total	Annual average
Nature of exogenous shifts	DS	DF	F	DS	DP	DS	DS	DF	DP	DP	F		
1. Agriculture and forestry	6.2	14.0	-10.5	15.7	-0.6	-5.5	-2.2	-1.0	-0.7	0.0	-0.6	14.7	1.4
2. Fishery	-7.6	18.6	-4.0	9.0	3.0	4.3	-4.9	0.9	-1.5	0.1	-1.1	16.9	1.6
3. Mining	17.1	23.3	-18.5	-4.9	12.8	-0.8	-6.1	0.9	-2.0	0.1	-2.8	18.9	1.7
4. Food, beverage and tobacco products	-4.5	13.2	-6.4	8.0	2.0	-3.1	0.2	-0.7	-1.4	-0.0	0.3	7.6	0.7
5. Non-metal products	3.2	22.3	-7.0	11.3	7.2	0.6	3.0	0.5	-1.1	0.1	-0.8	39.2	3.4
6. Metals, machines and equipment	5.3	31.8	-1.7	7.5	16.4	1.2	4.2	1.1	-2.6	-0.3	-2.9	60.1	4.8
7. Chemicals	5.6	32.5	-7.5	3.0	12.6	4.4	8.3	0.5	-3.1	-0.2	-1.4	54.8	4.5
8. Textile, clothing and footwear	1.5	21.4	19.2	9.0	4.0	0.2	-4.2	1.7	-0.6	0.5	-3.5	49.3	4.1
9. Other manufacturing products	-1.0	23.7	1.4	14.1	7.4	0.9	2.3	0.8	-0.7	0.0	-0.8	48.1	4.0
10. Gas, electricity and water	10.0	29.2	-2.1	2.0	12.0	1.1	1.0	0.3	-2.1	0.0	-1.1	50.3	4.2
11. Construction	-10.0	11.8	9.7	7.1	4.5	0.9	1.6	0.0	-0.5	0.0	1.3	26.4	2.4
12. Trade and repair	-5.9	17.2	11.5	8.0	4.6	1.3	-1.4	0.2	-1.7	0.1	0.3	34.1	3.0
13. Hotels and restaurants	0.1	20.5	-6.6	10.7	4.2	8.6	-0.8	0.6	-1.8	0.0	0.3	35.7	3.1
14. Transport and communications	-5.4	25.2	-1.7	2.3	11.4	4.7	-0.3	0.0	-2.2	0.0	-0.1	34.1	3.0
15. Financial services	-2.3	38.9	-10.2	-3.0	16.5	6.6	6.6	0.5	-3.4	0.1	-0.6	49.7	4.1
16. Property and business services	-2.2	27.9	1.4	-1.6	11.2	-0.1	-0.9	0.3	-0.6	0.1	-0.0	35.4	3.1
17. Public administration	4.2	16.5	15.2	2.3	5.9	0.0	1.8	-0.4	11.0	-0.1	3.5	59.9	4.8
18. Education	-6.1	21.4	7.1	1.1	8.8	0.5	1.2	-0.2	6.4	0.0	2.2	42.4	3.6
19. Health care	-1.5	24.7	4.0	0.0	10.6	1.9	1.2	0.0	1.7	0.0	1.8	44.5	3.8
20. Other services	-3.5	20.0	-1.6	10.4	5.3	3.2	1.1	0.4	-0.9	-0.0	1.2	35.3	3.1

Table 6. Decomposition results, employment by occupations, for 2011-2020 *(percentage change)*

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Occupation	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	Total	Annual average
	Nature of exogenous shifts	DS	DF	F	DS	DP	DS	DS	DF	DP	DP	F		
1	Leaders and managers	1.4	18.1	7.1	-12.4	6.2	-0.3	0.9	-0.1	4.8	0.0	1.8	27.5	2.5
2	High-level professionals	0.3	40.7	0.9	26.4	16.6	1.1	1.0	0.1	0.9	0.0	0.3	88.4	6.5
3	Mid-level professionals	-0.7	12.5	3.0	-22.5	6.9	1.0	1.0	0.1	2.4	0.0	0.9	4.5	0.4
4	Elementary professionals and technicians	0.0	13.7	1.6	-57.5	5.7	2.1	0.7	0.1	0.7	0.0	0.4	-32.6	-3.9
5	Skilled workers in services and sales	-1.8	16.7	3.6	13.8	5.0	2.6	0.1	0.3	-0.3	0.0	0.5	40.6	3.5
6	Skilled workers in agriculture	3.0	18.8	-10.5	69.9	1.3	-3.4	-3.5	-0.6	-1.1	0.0	-0.8	73.0	5.6
7	Skilled handicraftsmen and manual workers	-2.2	16.1	4.6	26.1	5.0	0.8	0.5	0.4	-0.8	0.0	-0.5	50.1	4.1
8	Assemblers and machine operators	-0.6	13.5	-0.9	6.0	9.2	-0.8	1.8	0.2	-0.5	0.0	-0.5	27.4	2.5
9	Unskilled workers in sales and services	-2.4	16.3	3.2	0.8	2.6	2.8	-0.2	0.3	-1.0	0.0	0.4	22.7	2.1
10	Unskilled workers in agriculture	3.7	12.1	-8.1	-14.7	-1.1	-3.8	-2.0	-0.7	-0.5	0.0	-0.5	-15.6	-1.7
11	Other Unskilled workers	-2.2	11.6	0.9	-40.0	1.0	0.7	1.4	0.2	-0.4	0.0	0.1	-26.6	-3.1

Table 7. Decomposition results, employment by qualification, 2011 – 2020 *(percentage change)*

	Qualification level	(1) Technical change	(2) Aggregate employment growth	(3) Foreign trading environment	(4) Occupation-specific input requirements	(5) Training	(6) Household preferences	(7) Import-domestic preferences	(8) Agricultural land supply	(9) Government spending	(10) Import tariffs	(11) Momentum	(12) Total	(13) Annual average
	Nature of exogenous shifts	DS	DF	F	DS	DP	DS	DS	DF	DP	DP	F		
1	No qualifications	0.0	14.9	0.0	0.0	-5.7	0.0	0.0	0.0	0.0	0.0	0.0	9.3	0.9
2	Short-term vocational training	0.0	-13.4	0.0	0.0	52.9	0.0	0.0	0.0	0.0	0.0	0.0	39.5	3.4
3	Long-term vocational training	0.0	-13.9	0.0	0.0	46.8	0.0	0.0	0.0	0.0	0.0	0.0	32.9	2.9
4	Professional high school	0.0	1.6	0.0	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0	10.3	1.0
5	College	0.0	15.6	0.0	0.0	13.6	0.0	0.0	0.0	0.0	0.0	0.0	29.2	2.6
6	University	0.0	53.9	0.0	0.0	22.1	0.0	0.0	0.0	0.0	0.0	0.0	76.0	5.8

Table 8. Decomposition results, wage rates by qualification, 2011 – 2020 *(percentage change)*

	Qualification level	(1) Technical change	(2) Aggregate employment growth	(3) Foreign trading environment	(4) Occupation-specific input requirements	(5) Training	(6) Household preferences	(7) Import-domestic preferences	(8) Agricultural land supply	(9) Government spending	(10) Import tariffs	(11) Momentum	(12) Total	(13) Annual average
	Nature of exogenous shifts	DS	DF	F	DS	DP	DS	DS	DF	DP	DP	F		
1	No qualifications	35.4	-3.2	27.9	-23.9	9.1	-1.3	4.6	-1.6	-1.0	0.3	1.1	47.3	3.9
2	Short-term vocational training	33.1	14.7	30.9	-12.6	-25.2	0.4	6.1	-1.2	-0.4	0.2	1.3	47.3	3.9
3	Long-term vocational training	33.5	15.3	30.9	-14.9	-24.8	0.5	6.4	-1.1	0.0	0.2	1.3	47.3	3.9
4	Professional high school	33.1	-0.5	34.2	-23.6	-8.7	1.4	6.9	-1.2	2.7	0.2	2.6	47.2	3.1
5	College	31.8	-20.5	38.0	-4.3	-16.5	2.3	7.8	-1.2	5.9	0.2	3.5	47.1	3.9
6	University	34.6	-54.9	37.9	34.3	-26.5	4.0	9.0	-1.0	5.7	0.1	3.7	47.0	3.9

Table 9. Decomposition results, wage rates by occupations, for 2011-2020 *(percentage change)*

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Occupation	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	Total	Annual average
	Nature of exogenous shifts	DS	DF	F	DS	DP	DS	DS	DF	DP	DP	F		
1	Leaders and managers	33.9	-31.5	36.5	-0.5	-14.8	1.6	7.4	-1.2	5.4	0.2	3.5	40.4	3.5
2	High-level professionals	35.7	-58.3	39.3	42.7	-28.3	4.4	9.6	-1.0	6.1	0.1	3.9	54.4	4.4
3	Mid-level professionals	31.1	-7.2	34.4	-24.3	-12.9	2.1	7.2	-1.1	4.2	0.2	3.0	36.6	3.2
4	Elementary professionals and technicians	28.4	-12.4	27.8	-39.2	-8.9	2.0	5.5	-1.0	1.8	0.2	2.1	6.4	0.6
5	Skilled workers in services and sales	35.7	-4.0	33.3	-10.9	-0.4	1.0	5.9	-1.4	-0.1	0.2	1.9	61.1	4.9
6	Skilled workers in agriculture	41.1	-5.1	27.5	12.9	4.8	-2.5	4.2	-2.0	-0.8	0.3	1.2	81.5	6.1
7	Skilled handicraftsmen and manual workers	36.7	1.5	34.3	-9.5	0.4	-0.3	6.0	-1.4	-0.7	0.3	1.2	68.5	5.4
8	Assemblers and machine operators	34.3	7.9	29.8	-15.0	-11.5	-0.7	6.6	-1.3	-0.4	0.2	1.2	51.1	4.2
9	Unskilled workers in sales and services	34.6	-4.2	31.3	-20.3	6.9	0.7	5.0	-1.4	-1.0	0.2	1.6	53.4	4.4
10	Unskilled workers in agriculture	35.5	-3.0	21.7	-31.7	8.9	-3.4	3.0	-2.0	-1.2	0.2	0.9	29.0	2.6
11	Other Unskilled workers	29.6	-2.1	25.5	-45.2	8.9	-0.6	4.9	-1.3	-1.0	0.2	1.1	20.1	1.8

The other main contributor to real GDP growth in column 1 is capital accumulation (row 11). With employment unchanged in column 1 (rows 8-10), for a given capital stock, the immediate effect of the rise in total factor productivity is to increase the marginal product of capital. If capital stocks were to remain unchanged at their 2010 levels, the productivity increase would cause the rate of return on capital to rise sharply. However, our model closure allows industry-specific capital stocks to adjust so as to maintain unchanged initial rates of return on capital.[13] Hence, with productivity growth placing upward pressure on capital rates of return for any given level of the capital stock, the capital stock must expand to ensure that industry-specific rates of return remain unchanged from their 2010 values. This accounts for a large proportion of the forecast growth in the capital stock to 2020.[14] It also explains why the increase in the average rental price of capital (row 17) is very similar to the increase in the average cost of capital (row 15). An indicator of the average economy-wide rate of return is the ratio of the rental price of capital to the average construction cost of capital. Our assumption of unchanged industry-specific rates of return on capital is manifested at the macroeconomic level by near equality of these two price indices across rows 15 and 17.

The rise in GDP also lifts real GNP (row 2), and with it, national savings. However, the additional savings generated by the rise in GNP are insufficient to fund the additional investment required over the period 2010-2020 necessary to generate the forecast 44.5 per cent rise in the capital stock by 2020 (row 11). That part of capital accumulation not financed by domestic savings is instead financed by foreign savings. This accounts for the rise in foreign liabilities as a proportion of GDP (row 20). The interest payments on these liabilities is one reason why the forecast increase in real GNP (row 2) is less than the forecast increase in real GDP (row 1). The other factor contributing to lower growth in real GNP relative to real GDP is decline in the terms of trade (row 19).

The forecast decline in Vietnam's terms of trade in column 1 is due to the strong growth forecast in Vietnam's export volumes as a result of technical change (row 6). The growth in Vietnam's export volumes is generated by the growth in import volumes (row 7). That is, with national consumption determined by national income, and national investment largely determined by movements in the national capital stock, import volume growth in column 1 must be financed by export volume growth. In column 1, import growth is strong because growth in economic activity in general is strong: that is, with production, consumption and investment higher in column 1, so too must be imports of consumer goods and inputs to current production and capital formation. Note that export volumes in column 1 expand by more than import volumes for two reasons. First, the decline in the terms of trade increases the volume of exports required to finance a given volume of imports. Second, the rise in net foreign liabilities (row 20) causes net foreign interest payments to rise. Vietnam's balance of trade must move towards surplus in column 1 in order to finance these additional interest payments. This movement towards surplus requires Vietnam's real exchange rate to depreciate (row 18, column 1).

Column 1 of Table 4 reports the impact on sectoral output of forecast changes in variables describing the economy's technical efficiency. Among the sectors forecast to experience the largest increases in output as a result of changes in technology are financial services (row 15), metals, machinery and

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[13] That is, our forecast is undertaken under a long-run closure, in which industry-specific capital stocks are endogenous, and industry-specific rates of return on capital are exogenous.

[14] The other contributor to capital expansion in column (2) is forecast capital bias in technical change. As explained in Section 3.3.5, we extrapolate into the forecast period the historically observed bias towards capital-using technical change evident in the recent history of Vietnam's economic development (see Giesecke and Tran 2009).

equipment manufacturing (row 6), chemical manufacturing (row 7) and other manufacturing (row 9). Among the sectors forecast to experience the smallest expansions in output due to economy-wide changes in technical efficiency are construction (row 11), public administration (row 17), trade and repair (row 12) and health care (row 19). Sectoral outcomes can be explained in terms of sector-specific efficiency changes, and changes in macro environment. Sectors forecast to be favourably affected by technical change are those that: i. experience large productivity improvements; ii. produce goods experiencing favourable input-using technical change; iii. export a large share of their output; and/or, iv. are import-competing[15].

Consider for example financial services (row 15). Technical change is forecast to have favourable supply-side and demand-side influences on this sector. On the supply side, the sector is forecast to experience a large improvement in input-using efficiency. Ceteris paribus, this causes the price of financial services to fall, inducing substitution towards this commodity. On the demand side, the sector is forecast to be subject to two favourable forces. First, financial services are used to facilitate trade, and as discussed above, forecast movements in technical change favour growth in trade. Second, among the forecast movements in input-using technical change is growth in input requirements of financial services.

In contrast, technical change is forecast to have relatively unfavourable supply-side and demand-side impacts on construction (row 11). Technical change is forecast to have two unfavourable supply-side influences on this sector. First, the sector's rate of primary-factor productivity growth is forecast to be below the average for the economy as a whole. This represents our continuation into the forecast period a trend observed in recent history.[16] Below average primary factor growth for the sector causes its relative price of its output to rise. Second, construction is intensive in the use of imports (such as cement) and labour. Hence technical-change-induced real depreciation and real wage growth places upward pressure on construction's per-unit production costs. This largely accounts for the relative increase in the investment price deflator (row 15, Table 3). On the demand-side, the macro effects of technical change cause the aggregate investment outcome to be lower than the GDP outcome. Since the bulk of the construction sector's output is used for investment, this damps the sector's growth relative to GDP.

To understand the labour market pressures created by forecast movements in variables describing the economy's technical efficiency, we begin with column 1 of Table 8, which reports forecast movements in wage rates by qualification. Technical change is forecast to place pressure at each end of the qualification spectrum, with those with no qualifications (row 1), and those with university level qualifications (row 6), forecast to experience the largest increases in wage rates.

Turning first to university-qualified labour, via Table A3.2, Appendix 3 we see that an important occupation for employment of university graduates is high level professionals (row 6, column 2). That growth in demand for high level professionals might be responsible for the pressure on wages of university graduates is clear from Table 9, where we find high level professionals are forecast to

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[15] See Table A5.1, columns 1 and 2 the value of technical changes. See Table A2.3, columns 4 and 8, for the share of exports in commodity sales, and the share of import of commodities in local market respectively.

[16] Indeed, Giesecke and Tran (2009) uncovered apparent technological regress for the construction sector over the historical period 1996-2003. As discussed in Section 3.3.5, this technological deterioration is not assumed to continue into the future. However, we assume that the sector does not receive above-average shifts in primary factor technical change. This has the effect of delivering to the sector a below-average rate of productivity growth.

experience above-average growth in wages as a result of technical change (row 2). In Table A3.3, Appendix 3 we see that some of the most important employers of high level professionals (property and business services, chemical manufacturing; metals, machines and equipment manufacturing, financial services) are also among the sectors forecast to experience the strongest output growth as a result of technical change (see column 1, Table 4).

Workers with no qualifications mostly find employment in the "unskilled worker" occupation (Table A3.2, row 1, columns 9-11). In Table A3.3 we find that the agriculture and forestry sector is the major employer of unskilled workers. In Table 4, we see that the agriculture and forestry sector is forecast to experience output growth approximately on par with real GDP growth. However, the capacity of the agriculture and forestry sector to expand output is constrained in column 1 by the fixity of agricultural land. Hence, output growth on its own is an unsatisfactory indicator of employment pressure for agriculture and forestry. Turning to Table 5, which see that agriculture is forecast to experience comparatively high employment growth as a result of forecast movements in the economy's technical efficiency (row 1). In column 1, employment in aggregate is held at its 2010 level, so employment growth in any one sector must be at the expense of employment in other sectors. Employment growth in agriculture and forestry is positive because of the large real exchange rate depreciation forecast in column 1 (Table 3, row 18). Agriculture and forestry is trade-exposed through export sales. Real exchange rate depreciation produces an increase in demand for output of the agricultural and forestry sectors. With agricultural land supplies fixed, this expansion in output must be generated by the sector expanding employment. Since agriculture and forestry is a major hirer of the unskilled worker occupation, and since this occupation is a major employment destination for workers with no qualifications, we find that employment expansion in the agriculture and forestry sector places upward pressure on the relative wages of workers without qualifications.

4.2 Aggregate employment growth (Column 2)

Column 2, Tables 3 – 9, isolates the effects of growth in aggregate employment over the forecast period, under an assumption that the proportional allocation of training resources across skill categories remains unchanged from 2010 values.[17]

Total employment (persons) is forecast to grow by 14.8 per cent over the period (Table 3, row 8, column 2). Note that hours-weighted employment (row 9) and wagebill-weighted employment (row 10) are forecast to grow by slightly more than persons. This reflects the 2010 pattern of training resources, which is weighted towards university and college places, relative to professional high school and vocational places. University and college graduates earn above-average hourly wage rates, and work above-average hours per week. With the 2010 pattern of training resources favouring growth in these skill categories (Table 8, Column 2), growth in hours-weighted employment and wagebill-weighted employment exceeds forecast growth in employment of persons (compare rows 8-10, column 2, Table 3).

The main macroeconomic forces at work in column 2, Table 3, are as follows. Ceteris paribus, growth in aggregate employment causes the marginal product of the existing capital stock (and with it, the rate of return on capital) to rise. However, our forecast period is sufficiently long for capital accumulation to occur such that rates of return do not deviate from their initial base-period values.

[17] The effects of aligning training resources with forecast labour force needs are isolated in Column 5 and discussed in Section 4.5.

This explains the growth in the capital stock (row 11). With employment and capital rising, so too does real GDP (row 1).

The investment required to generate the forecast growth in capital in column 2 is larger than the additional national savings generated by employment growth. This accounts for the rise in the ratio of net foreign liabilities to GDP (row 20). In column 2, national consumption spending is a fixed share of national income. With foreign liabilities rising as a share of GDP, and with it, interest payments on those liabilities, real gross national income must increase by less than national real GDP. This explains why real private and public consumption growth is lower than real GDP growth (compare rows 3, 4 and 1).

A further factor that depresses consumption growth in column 2 relative to real GDP growth is a decline in the terms of trade (row 19). With the economy expanding in column 2, imports must grow (row 7). This requires growth in export volumes to finance these additional imports (row 6). To facilitate this export growth, Vietnam's foreign currency export prices must fall. This accounts for the decline in the terms of trade in column 2.

The decline in the terms of trade has consequences for the real wage both directly, by reducing income available to fixed factor (labour and land), and indirectly, via its effect on the capital / labour ratio. Ceteris paribus, the decline in the terms of trade reduces the value of the marginal product of capital. Since we assume that capital stocks adjust to maintain base period rates of return on capital, the impact of terms of trade decline on the value of the marginal product of capital must be offset by a rise in the labour / capital ratio (compare rows 9 and 11, column 2). Together, these two factors (the fall in national income, and the fall in the capital/labour ratio) account for the decline in the real wage (row 16, column 2).

With growth in real consumption lower than growth in real GDP in column 2, the real balance of trade must move towards surplus (rows 6 and 7, column 2). This requires the real exchange rate to depreciate (row 18, column 2).

Turning to the sectoral results (Table 4), we find that sectors that are labour-intensive, export-oriented and/or import competing tend to experience the largest output gains from growth in aggregate employment. Such sectors either gain cost advantage from the reduction in the real wage, or demand growth via the expansion in the volume of foreign trade. These sectors include financial services (a labour intensive sector); and metals, machinery and equipment; and chemicals (which are in the traded goods sector, and thus benefit from real depreciation). Note that the potential for the mining, agriculture and forestry sectors to expand in column 2 is constrained by fixity of natural resource supplies to these sectors.

The sectoral results are also influenced by the occupational composition of industry-specific labour requirements. Recall that in column 2, the qualification-acquisition patterns of new entrants to the labour force remain at 2010 values. This promotes supplies of university and college level qualifications relative to vocational and professional high school qualifications (column 2, Table 8). Sectors like financial services, property and business services, which are intensive users of occupations in which university and college qualified persons work, benefit from the decline in the relative wages of university and college qualified persons (column 2, Table 8). University-qualified workers in particular experience a relatively large fall in wages as a result of general labour force growth (Table 8, column 2, row 6). This reflects that government is an important consumer of health, education, and public administration – sectors that are intensive in the use of university-qualified labour. Government demands are price inelastic. Hence, in the absence of any other structural changes in the economy, a relatively large fall in the wage rate of university-qualified labour would be required to absorb the forecast growth in university-qualified labour in column 2.

4.3 Foreign trading environment (Column 3)

As discussed in Section 3.3.4, in the forecast simulation, we assume that demand for Vietnamese exports will grow over the simulation period by an amount sufficient to leave the country's terms of trade unchanged from its 2010 value. This is achieved by endogenously determining a variable describing foreign willingness to pay for Vietnamese exports. During the forecast simulation, foreign willingness to pay for Vietnamese exports must grow by 15.5 per cent to maintain Vietnam's terms of trade at its 2010 level.[18] In the decomposition simulation, this movement in willingness to pay is imposed as an exogenous shock, and its impact on the economy is reported in Column (3) of Tables 3 – 9. This column should be interpreted as a combination of the impact of general growth in the world economy on demand for Vietnamese exports, and the results of successful efforts on the part of Vietnamese entrepreneurs to find new foreign markets for their exports over the forecast period.

We have assumed in our decomposition simulation that industry-specific capital stocks adjust to maintain given rates of return on capital. For a given level of the capital stock, the rise in the terms of trade causes the value of the marginal product of capital to rise, and with it, the rate of return on capital. This attracts investment, and capital stock expands until the rate of return comes back to the 2010 level. This accounts for the rise in Vietnam's capital stock (row 11, column 3). The increase in the capital stock causes real GDP to rise (row 1, column 3). Note that the growth in real GNP (row 2, column 3) exceeds the increase in real GDP (row 1, column 3). There are two influences on real GNP in column 3. First, the terms of trade growth promotes expansion of the capital stock. However, the additional savings generated out of the increase in real GNP are not sufficient to finance all of the investment required between 2010 and 2020 to increase Vietnam's capital stock by 22.8 per cent (row 11, column 3). Hence, net foreign liabilities must rise (row 20, column 3). This damps real GNP growth relative to real GDP growth. However, an important determinant of real GNP is the terms of trade, and Vietnam's terms of trade grow strongly in column (3). In column (3), the positive impact on real GNP of terms of trade growth exceeds the damping influence of growth in net foreign liabilities, leaving the increase in real GNP higher than the increase in real GDP.

We assume that national consumption (private and public) is a fixed proportion of national income. Hence, with real GNP higher (row 2, column 3) so too is real private and public consumption spending (rows 3 and 4, column 3). Note that because the percentage increase in real GNP exceeds the percentage increase in real GDP, so too must the percentage increase in real consumption exceed the percentage increase in real GDP.

As discussed in Section 3.3.3 we assume that industry-specific investment/capital ratios remain at their 2010 levels over the forecast period. With the capital stock rising by 22.8 per cent in column 3, the growth in the aggregate investment is of a similar magnitude, at 23.3 per cent. This exceeds the percentage growth in real GDP. Hence, together with the growth in real private and public

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[18] That is, the vertical position of Vietnam's export demand schedules rises by 15.5 per cent. The average value of Vietnam's export demand elasticity is approximately -5. Hence, our 15.5 per cent vertical shift in Vietnam's export demand schedules is equivalent to an 77.5 per cent horizontal shift in Vietnam's export demand schedules. This represents an annual average growth rate in the volume of Vietnam's exports, for any given export prices, of approximately 5.9 per cent per annum.

consumption, we find that the growth in real GNE exceeds the growth in real GDP. This requires the real balance of trade to move towards deficit (compare rows 7 and 6, column 3). For the balance of trade to move towards deficit, the real exchange rate must appreciate (row 18, column 3).

Column (3) of Table 4 reports the sectoral impacts of forecast growth in demand for Vietnam's exports. These sectoral impacts follow directly from the macroeconomic impacts discussed above. Appreciation of the real exchange rate damps activity in export and import-competing sectors. This accounts for the relatively poor prospects in column (3) for sectors such as agriculture; fishery; mining; food, beverages and tobacco; non-metallic mineral product manufacturing; and chemical manufacturing. It also accounts for the relatively poor prospects for hotels and restaurants, and other services (both of which sell to foreign tourists) and finance and business services (which sells trade-facilitating services to exporters and importers).

Because the expansion in the terms of trade favours growth in consumption relative to real GDP (see above), we find that sectors that mainly service domestic consumption demands, whether private or public, experience the largest output expansions in column (3).

To understand the labour market pressures created by the forecast growth in demand for Vietnam's exports, we begin by examining skill-specific wage rates (Table 8, column 3). We find that the expansion in wage rates is greatest for the university, college and professional high-school qualifications. This reflects growth in demand for qualifications such as leaders and managers, high-level professionals, mid-level professionals, and skilled service workers (column 3, Table 6). These occupations are used intensively in the service sectors that are the main beneficiaries of the fact that growth in demand for Vietnam's exports causes real consumption growth to exceed real GDP growth.

Employment in certain occupations, in particular skilled agricultural workers, assemblers and machine operators, and unskilled agricultural workers, is forecast to fall as a result of general growth in demand for Vietnam's exports (Table 6, column 3). This causes the relative wages of those qualifications that are employed most intensively in these occupations (namely, no qualifications, short-term vocational training, and long-term vocational training) to fall (column 3, Table 8). Again, the explanation for these labour market outcomes can be found in the macroeconomic results. Growth in demand for Vietnam's exports causes Vietnam's real national income to rise via an increase in the terms of trade. The rise in national income promotes real consumption growth, which causes the real exchange rate to appreciate. Appreciation of the real exchange rate causes growth in output and employment in trade-exposed sectors to be lower than growth in output and employment in sectors that service domestic consumption. Trade exposed sectors, such as agriculture, mining and manufacturing, are important employers of occupations such as skilled agricultural workers, assemblers and machine operators, and unskilled agricultural workers.

4.4 Occupation-specific input requirements (Column 4)

In Section 3.3.8 we discussed how historical changes in occupation-specific input requirements are inferred from historical evidence on changes in occupation- and industry-specific wage rates and employment levels. In our forecasting simulation, we assume that these historical trends in changes in the occupational composition of labour demand will continue into the future, albeit at a reduced rate. Column 4 of Tables 3 – 9 isolates the effects of these forecast changes in the autonomous component of occupation-specific labour demands.

The nature of our forecast changes in the autonomous component of occupation-specific input-demands is clearest in Table 9, which reports changes in occupation-specific employment. In column 4 we see strong employment growth for skilled agricultural workers, skilled craft and trades workers, high-level professionals, and skilled workers in service and sale, and a modest growth for assemblers and machine operators. This reflects our forecast shift in labour requirements towards these occupations and away from other occupations.

As discussed in Section 2.3.7, we implement autonomous movements in occupation-specific labour demands as cost-neutral twists in the occupational composition of industry-specific inputs of labour. As such, the economy's technical efficiency is not affected by the forecast movements in labour input requirements. The reader will nevertheless note that the forecast autonomous shifts in labour input requirements increase real GDP by 6 per cent (Table 3, row 1, column 4). This increase in real GDP is due to an increase in wagebill weighted employment (row 10, column 4). In column 4 employment (measured in persons) by skill is unchanged from its 2010 level (see column 4, Table 7). However, as discussed in Section 2.3.1, the holders of each skill type are free to change their labour supply to particular occupations in response to a change in relative wage rates across occupations. Recall that in Section 2.3.1, we account for the fact that holders of a particular skill are observed to allocate their labour across occupations with differing wage rates on the basis that a given worker's job satisfaction differs across occupations. This idea is implemented by assuming that a given worker will value a dong earned in an occupation differently, depending on the occupation in which it is earned. At the population level, and indeed in some cases, the individual level, we can thus explain why the holders of a given skill do not uniformly crowd into the highest paying occupation for which their skill is suitable. This background allows us to account for the increase in wagebill weighted employment (and with it, the increase in real GDP) apparent in column 4. The forecast cost-neutral changes in labour input requirements favour, on average, high-wage occupations relative to low-wage occupations. Ceteris paribus, this causes a rise in the relative wage of high-wage occupations relative to low-wage occupations. At the margin, this induces workers to reduce the number of employment hours that they allocate to low-wage occupations and increase the number of hours they allocate to high-wage occupations. This causes wagebill-weighted employment to rise (Table 3, row 10, column 4) even though the total number of employed persons (Table 3, row 8, column 4), and the total number of hours allocated to employment (Table 3, row 9, column 4), are unchanged from 2010 levels.

4.5 Training (Column 5)

Column 5 isolates the effects of changing the skill-acquisition composition of new entrants to Vietnam's labour force over the period 2010-2020. We assume that the allocation of Vietnam's training resources is realigned in a way that ensures that initial wage relativities across skill categories are maintained in the year 2020. This explains why, in column 12 of Table 8, the net 2020 outcomes for skill-specific wages are identical across skill types. Without a change in the composition of the skill-acquisition patterns of new entrants to the workforce over the period 2010-2020, this would not be the case, as is clear from the results in column 5 of Table 8. Here, we see that forecast changes in the skill-acquisition patterns of workforce entrants has a substantial damping effect on the wages of university and college qualified workers, as well as workers with short- and long-term vocational qualifications. The implication of these results is that, without a realignment of Vietnam's training resources over the forecast period, too few workers with these qualifications will be available in the year 2020, leading to their wage rates rising substantially. For example, the result for university-qualified labour in column 5 of Table 8 can be interpreted as meaning that wages of university-qualified workers will be 20.9 per cent[19] higher than otherwise forecast in column 12, if training policy is not adapted to accommodate forecast growth in demand for university-qualified labour. The expansion in the level of university-qualified labour-force participants required to achieve this wage reduction is reported in column 5 of Table 7, along with the required changes in supply of labour with other qualifications. As is clear from Table 7, the allocation of training resources necessary to maintain base year wage relativities involves an expansion in overall training effort (that is, the number of workers with no vocational training must fall by 5.7 per cent), and particular attention to short- and long-term vocational training and attainment of college and university qualifications.

The national benefits of devoting policy attention to the qualifications of Vietnam's new labour market entrants are clear from the macroeconomic results (Table 3). We see that training policy alone is forecast to contribute 6.2 percentage points to Vietnam's forecast real GDP growth (row 1, column 5). In annual terms, this represents 0.61 percentage points of the 8.0 per cent annual average growth forecast over the period (row 1, column 13). We can trace the source of the real GDP gain to rows 8 – 10 of column 5. Recall that in column 5 we do not change the total number of new entrants to the labour force[20], only the skill composition of the new entrant stream. This explains why employment of persons in column 5 is unchanged from its 2010 value (row 8). Note however that wagebill-weighted employment rises by 6.4 per cent (row 10, column 5). This is so for two reasons. First, workers with vocational training, professional high-school, college or university qualifications work, on average, more hours per week than do those with no vocational training (Appendix 4). This explains why total employment in hours rises, even when the total number of employed persons is unchanged (row 9, column 5). Second, as discussed in the preceding paragraph, the realignment of training resources described in column 5 promotes supply of qualifications the relative wages of which are rising, and reduces supply of qualifications the relative wages of which are declining. This explains why wagebill-weighted employment rises by more than employment measured in hours (row 10, column 5). For understanding macroeconomic impacts, wagebill weighted employment is the relevant employment measure, because it weights employment changes according to the value of the marginal product (or GDP contribution) of different skill types.

We assume that our forecast period is sufficiently long for capital stocks to adjust to maintain base period rates of return on capital. If capital stocks were unchanged from their 2010 levels, the expansion in wagebill-weighted employment would cause rates of return on capital to rise. To maintain rates of return at their base period values, capital stock must expand (row 11, column 5). Together with the rise in wagebill-weighted employment, this accounts for the expansion in real GDP (row 1, column 5).

The expansion in the 2020 capital stock is financed partly by the additional domestic savings generated by the rise in GDP in column 5, and partly by a rise in net foreign debt (row 20, column 5). The increase in interest financing costs associated with the rise in net foreign debt explains why national consumption (rows 3 and 4) rises by less than real GDP (row 1). The welfare gain implicit in the rise in real private and public consumption is substantial. Our macroeconomic closure underlying the results in column 5 assumes that the average propensity to consume out of national income is

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[19] $= 100 * (1 / (1 - 0.265) - 1)$.

[20] The effect of changing the absolute number of new entrants, holding their skill acquisition patterns unchanged, is reported in column 2.

constant. Hence, we can infer that with real private and public consumption spending rising by over 4.5 per cent, so too is real (consumption price deflated) gross national income. In 2009, Vietnamese gross national income per capita was $USD 1,032.[21] A 4.5 per cent increase in national income thus represents an income gain of $46.3 per capita, or approximately $194 per household[22].

The shocks in the five columns discussed above are the most important contributors to changes in the economy and in employment. They explain 98.1 per cent of the total change in GDP. The remaining columns have small effects on the economy, and will only be discussed briefly below.

4.6 Household preferences (Column 6)

Column 6 reports the effects of changes in household tastes in their consumption. The percentage change form of the VNET household demand equations is:

$$x_i^{(H)} = q + \varepsilon_i (c - q) + \Sigma_j \eta_{ij} p_j^{(H)} + a_i^{(H)} - \Sigma_k S_k^{(H)} a_k^{(H)} \quad \text{(E41)}$$

where $x_i^{(H)}$ is household demand for commodity *i*; q is the number of households; ε_i is the expenditure elasticity for *i*; c is household income; η_{ij} is the elasticity of demand for *i* with respect to the price of *j*; $p_j^{(H)}$ is the consumer price of commodity *j*; $a_i^{(H)}$ is a shift in tastes towards *i*; and $S_k^{(H)}$ is the share of *k* in the household budget. As can be seen from the equation, in the absence of price or income changes, demand for *i* moves broadly in proportion with changes in $a_i^{(H)}$ - the preference for *i*. Hence, sectors producing goods experiencing favourable (unfavourable) taste shifts will tend to expand (contract). The degree to which a sector's output is affected by taste change depends on the importance of consumption in the sector's total sales.

As discussed in Section 3.3.7, household tastes shift towards services (such as tourism, transport and communication, financial services, education, utilities) and manufacturing products (such as machinery and equipment, pharmaceuticals, and cosmetic products). They move away from primary commodities (such as agriculture, mining and metal products).

The macro effects of taste changes are small (column 6, Table 3). These effects arise mainly from taste change shifting activity between sectors with different capital-labour ratios. The sectors favoured by taste change tend to be more capital-intensive than those experiencing adverse taste shifts[23]. With employment fixed in this column, the shift in the composition of consumption towards capital-intensive goods causes the capital stock to rise (row 11). Although employment numbers are unchanged, wage-weighted employment rises slightly (rows 8 and 10). This is due to the expansion of higher wage sectors (such as manufacturing and services) and contraction of lower wage sectors (such as agriculture) (see column 6, Table 4). Together, the increase in capital stock and wagebill-weighted employment account for the rise in GDP in column 6, Table 3.

Industries experiencing the largest output expansions (hotels and restaurants, financial services, transport and communications, and chemicals) are important employers of skilled workers in personal services, social safety protection and sales (row 5, column 6, Table 6) and unskilled workers in sales

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[21] World Development Indicators, accessed February 2011 at http://databank.worldbank.org/ddp/home.do?Step=3&id=4.

[22] Assuming approximately 4.2 persons per household (GSO 2008a). If we use the purchasing power parity per capita income of US$2790 in 2009 (WDI), then the gain per household would be approximately US$526.

[23] In the sectors experiencing favourable taste shifts, capital payments represented 51.2 per cent of primary factor payments. In sectors experiencing adverse taste shifts, the same share was only 33.5 per cent.

and services (row 9, column 6, Table 6). Consistent with the decline in agricultural output, the occupations experiencing the largest declines in employment are those associated with agriculture: skilled workers in agriculture (row 6, column 6, Table 6) and unskilled workers in agriculture (row 10, column 6, Table 6).

4.7 Preferences for imported/domestic varieties of each good (Column 7)

Column 7 isolates the effects of shifts in commodity-specific import/domestic preference variables. For each non-government domestic agent in VNET, the percentage change in the ratio of imported to domestic demands for good *i* are given by equations of the form:

$$(x_{i,imp} - x_{i,dom}) = -\sigma_i (p_{i,imp} - p_{i,dom}) + twistm_i \qquad \text{(E42)}$$

where $x_{i,imp}$ and $x_{i,dom}$ are percentage changes in demand for imported and domestic good *i* respectively; $p_{i,imp}$ and $p_{i,dom}$ are percentage changes in prices of imported and domestic varieties of *i* respectively; σ_i is the elasticity of substitution between domestic and imported *i*; and $twistm_i$ is a cost-neutral shift in preferences for imported/domestic varieties of *i*.

As discussed in Section 3.3.4, we conjecture that, ceteris paribus, the openness ratio in 2020 will be slightly smaller than that in 2010. We implement this by reducing the value for *twistm*, which uniformly affect all imports.

At the macro level (Table 3, column 7), the twist away from imports causes aggregate import volumes to decline (row 7). As the domestic economy absorbs more domestically-produced goods, export volumes decline (row 6). This causes the terms of trade to improve (row 19), which, for a given level of capital stock, causes the value of the marginal product of capital to rise. To prevent rates of return from rising relative to their 2010 level, capital stock must expand (row 11). With investment/capital ratios exogenous, this causes aggregate investment to rise (row 5).

At the sectoral level (Table 4, column 7), because of the decline in aggregate export volumes, we find export-oriented industries contracting. These include textile, clothing and footwear, fishery, mining, and agriculture. The decline in import volumes causes import-competing industries to expand. These include metals, machinery and equipment, non-metal products, and many other manufacturing industries. Changes in industry employment (Table 5, column 7) closely follow changes in industry outputs.

The declines in output of export-oriented sectors such as agriculture, fishery and mining lead to a fall in demand for occupations used intensively in these industries, such as skilled workers in agriculture, and unskilled workers in agriculture.

4.8 Agricultural land supply (Column 8)

As discussed in Section 3.3.9, agricultural land is expected to decline over the forecast period. The decline is largest for paddy, and lower for other crops. Land for aquaculture, however, is assumed to stay unchanged. Overall, aggregate land supply is expected to decline by 3.3 per cent (Table 3, row 12, column 8). This causes the labour-land ratio in agricultural industries to rise, and the real wage to fall. As land constitutes only approximately 10 per cent of GDP at factor costs, its effects on GDP and other macro variables are small.

At the industry level (Table 4, column 8), agricultural output declines, as does output in those industries which rely on agricultural products as inputs, such as food, beverage and tobacco products.

This accounts for the falls in employment in agriculture and food beverages and tobacco (rows 1 and 4, column 8, Table 5). This accounts for the decline in employment in those occupations used intensively in these industries (rows 6 and 10, column 8, Table 6). Employment in other occupations increases, as workers respond to the declining relative wages in these occupations (rows 6 and 10, column 8, Table 9) by supplying more labour to other occupations.

4.9 Government spending (Column 9)

As discussed in Section 3.3.2, we assume in our forecast that the growth rate of public consumption spending is slightly higher than the growth rate of real GDP. In the forecast, this required the endogenous determination of the ratio of public to private consumption spending. This ratio must rise during the forecast simulation. Column 9 isolates the effects of imposing, as an exogenous shock, the forecast value for the increase in the ratio of public to private consumption spending in the decomposition simulation. This causes real public consumption to increase by 13.5 per cent (row 4, Table 3). Note that in column (9), our assumption that aggregate consumption is a fixed proportion of GNP continues to hold. Since GNP changes little in column (9), the rise in public consumption spending must be matched by a decline in private consumption spending (row 3, column 9).

Relative to public consumption spending, private consumption spending is capital intensive. Hence, the movement in aggregate consumption spending away from private consumption and towards public consumption causes the aggregate capital stock to fall (row 11, column 9). Since investment / capital ratios are exogenous, the decline in the capital stock causes real investment to decline (row 5).

Industries which supply a high proportion of their outputs to government, such as public administration and defense, education, and health care, expand (rows 17-19, Table 4). These industries are important employers of occupations such as leaders and managers, high-level professionals, and mid-level professionals. Hence, employment in these occupations increases (rows 1-3, Table 6). Aggregate employment in column (9) is exogenous. Hence the employment gains in these occupations must be matched by employment falls in other occupations. The aforementioned occupations are mainly occupied by workers with university, college and professional high school qualifications. Hence, the increase in public consumption spending places upward pressure on the wages of workers with these qualifications (rows 4 – 6, Table 8).

4.10 Import tariffs (Column 10)

As discussed in Section 3.3.4, Vietnam plans to reduce tariffs over the forecast period. However on average, the reductions are small, and hence so too are the expected economy-wide and sectoral consequences. As such our discussion of trade tax impacts is brief. Trade promotion is the immediate macro effect of lower trade taxes. This accounts for the rise in import and export volumes (rows 7 and 6, Table 3). Since investment is relatively import-intensive, tariff reduction lowers the price of investment. Ceteris paribus, tariff reduction also increases the post-tax value of the marginal product of capital, because tariffs are an input tax on current production. With rates of return exogenous, both effects promote capital formation (row 11). The increase in capital causes GDP to rise (row 1). With investment / capital ratios exogenous, the rise in capital causes investment to increase (row 5). Despite the rise in GDP, the decline in the terms of trade (row 19) induced by export expansion causes GNP to decline, and so too does real consumption. Note however that these effects are small.

Looking across row 1, we find changes in import tariff accounted for little (only 0.1 percentage points) of the expansion in Vietnamese real GDP. This follows from the average trade tax reduction being small. However, trade tax cuts were only part of Vietnam's trade liberalisation program. As already discussed above in the context of column 3, other trade liberalisation measures (such as reducing barriers to trade by Vietnam's trading partner and promoting exports) also contribute to GDP growth.

Turning to Table 8, we see that forecast reductions in import tariffs cause no change in relative wages across qualifications. This indicates that the labour market pressures generated by tariff reduction are spread quite evenly across qualifications. This suggests that tariff reductions are not likely to generate much need to adjust training policies.

4.11 Momentum (Column 11)

Column 11 reports what would happen to the economy between 2010 and 2020 if none of the structural and policy changes described by columns 1-10 were to occur. Under these circumstances, NFL falls sharply (row 20). This reflects the fact that Vietnamese savings are far higher than that needed simply to maintain the 2010 size of the Vietnamese capital stock. The relevant mechanism is made clearer by examining a stylised representation of the VNET net foreign liabilities equation[24]:

$$\Delta \mathrm{NFL} = \tau \cdot \mathrm{K} \cdot \mathrm{D} - \tau \cdot \mathrm{GNP} \cdot (1 - \mathrm{APC}) \qquad \text{(E43)}$$

where $\Delta\mathrm{NFL}$ is the change in net foreign liabilities over the study period, τ is the study period in years, K is the initial capital stock, D is the depreciation rate, GNP is gross national product, and APC is the propensity to consume out of GNP. Since Vietnam's base-period domestic savings ($\mathrm{GNP} \cdot (1 - \mathrm{APC})$) far exceed depreciation investment ($\mathrm{K} \cdot \mathrm{D}$), even in the absence of any shocks to the economy over the forecast period (represented by columns 1 – 10), NFL must fall over the forecast period.

The fall in NFL causes net interest payments abroad to fall. This accounts for the rise in real GNP (row 2). With GNP higher, so too is private and public consumption spending (rows 3 and 4). Note that, in column 11, our macroeconomic closure allows for little change in real GDP. That is, with technical change, rates of return, and employment held constant in column 11, growth in the capital stock is effectively constrained, and hence so too is real GDP (row 1, column 11). With consumption higher but GDP rising only slightly, the balance of trade must move towards deficit (compare rows 5 and 6, column 11). This requires the real exchange rate to appreciate (row 18, column 11).

The rise in private and public consumption is reflected in expansions of those sectors most directed towards satisfying domestic consumption spending. This explains the growth of sectors such as construction, public administration, education, health care and other services in column 11. Trade-exposed sectors, whether via exports or import competition, are adversely affected by real appreciation. This accounts for the contraction in the output of agriculture, fishery, mining, and manufacturing in column 11.

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[24] The VNET net foreign liabilities equation is styled on the MONASH net foreign liabilities equation. A fuller (but still simplified) description of the relevant equation, of which Equation (E43) is a stylised representation, is:

$$NFL_{t+\tau} = NFL_t + \sum_{s=0}^{\tau-1}[K_{t+s+1} - K_{t+s}(1-D)] - \sum_{s=0}^{\tau-1}[(1-APC_{t+s}) \cdot GNP_{t+s}]$$

where t is the initial year (2010), τ is the solution year (2020), D is the rate of depreciation, and all other variables are as defined in the main text. See Dixon and Rimmer (2002:43-47) for details.

To understand the labour market pressures created by Vietnam's savings, we begin by examining skill-specific wage rates (Table 8, column 11). We find that the expansion in wage rates is greatest for the university, college and professional high-school qualifications. This reflects growth in demand for occupations such as leaders and managers, high-level professionals, mid-level professionals, and skilled service workers (column 11, Table 6). These occupations are used intensively in the service sectors that are the main beneficiaries of the fact that Vietnam's high savings rate causes real consumption growth to exceed real GDP growth.

Employment in certain occupations, in particular skilled agricultural workers, skilled handicraftsmen and manual workers, assemblers and machine operators, and unskilled agricultural workers, is forecast to fall as a result the accumulation of initial savings (Table 6, column 11). This causes the relative wages of those qualifications that are employed most intensively in these occupations (namely, no qualifications, short-term vocational training, and long-term vocational training) to fall (column 3, Table 8). Again, the explanation for these labour market outcomes can be found in the macroeconomic results. Accumulation of Vietnam's excess savings above depreciation investment over the forecast period causes real national income to rise by reducing net foreign liabilities. The rise in national income promotes real consumption growth, which causes the real exchange rate to appreciate. Appreciation of the real exchange rate causes growth in output and employment in trade-exposed sectors to be lower than growth in output and employment in sectors that service domestic consumption. Trade exposed sectors, such as agriculture, mining and manufacturing, are important employers of occupations such as skilled agricultural workers, skilled handicraftsmen and manual workers, assemblers and machine operators, and unskilled agricultural workers.

5 CONCLUDING REMARKS

In this paper we have demonstrated how a large-scale CGE model can be used to bring to bear sophisticated economic theory and very detailed economic data on the complex task of labour market forecasting. In interpreting our results, we identified the pressures for labour market adjustment chiefly in terms of movements in relative wages across qualifications and occupations. As they are indicators of economic value and relative scarcity, wages are the proper focus of policy makers when formulating a policy response to emerging labour market pressures. Indeed, our decomposition includes the effects of policy makers successfully tailoring education policy to ensure that qualification attainment propensities adjust to changing workforce needs. We showed that the benefits of such adjustment are substantial, raising 2020 real GNP per capita by 4.5 per cent relative to its 2010 value.

In our view, the use of large-scale CGE models in labour market forecasting can generate much valuable information for policy markers charged with the efficient allocation of training resources. Moreover, that information is complementary to information available from other sources (such as the consensus views of educational experts) for several reasons. First, the CGE forecasts are coherent. All the forecasts are consistent with each other, and with a defensible view about the future outlook for the economy. Second, the forecasts embody large amounts of relevant economic data and expert opinion. As a formal modelling system, the CGE model provides a comprehensive framework for incorporating data from a wide variety of sources in a consistent manner. Finally, the forecasts can be regularly updated, as our understanding of the future prospects for the economy evolves. We expect the framework will facilitate the allocation of research effort aimed at continually improving the forecasts, by allowing policy makers and researchers to distinguish between factors that are important and unimportant in determining future labour market outcomes.

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Appendix 1. Industries, Occupations and Qualifications in VNET

A.1. Industries

There are 113 industries in VNET. For reporting purposes, we aggregate them into 20 sectors. The sectors and their component industries are reported below.

Sector 1. Agriculture and forestry: 1. Paddy; 2. Natural rubber in raw forms; 3. Kernel coffee beans; 4. Sugar cane; 5. Un-fermented or partly-fermented tea leaves; 6. Other crops, nec.; 7. Pigs; 8. Cows; 9. Chickens, ducks, geese, etc; 10. Other livestock, incl. raw materials from them; 11. Irrigation services for agriculture; 12. Other services to agriculture; 13. Forest activities and products.

Sector 2. Fishery: 14. Fishing; 15. Aquaculture.

Sector 3. Mining: 16. Coals and lignite, peat; 17. Metal ores; 18. Stones; 19. Sands, pebbles, gravel, crushed stone; 20. Natural bitumen, asphalt, and other minerals; 21. Crude petroleum and natural gas.

Sector 4: Food, Beverage and tobacco products: 22. Meat products; 23. Animal and vegetable oils and fats; 24. Processed dairy products; 25. Bakery and confectionary products; 26. Processed fruits and vegetables; 27. Alcoholic beverages; 28. Malt liquors and malt; 29. Soft drinks; bottled mineral waters; 30. Sugars and their by-products; 31. Coffee products; 32. Tea products; 33. Tobacco products; 34. Processed sea foods; 35. Milled rice; 36. Food products n.e.c; 37. Preparations used in animal feeding

Sector 5. Non-metal product: 38. Glass and glass products; 39. Ceramic and other clay products; 40. Bricks and tiles; 41. Cements ; 42. Concrete and other cement products; 43. Other building materials; 44. Pulp, paper and paper products; 45. Wood and wood products.

Sector 6. Metals, machines and equipment: 46. Medical equipment and appliances; 47. Optical and precise equipment; 48. Domestic appliances and parts thereof; 49. Motor vehicles, motorbikes, motorised bicycles; 50. Automobiles and parts; 51. Agricultural or forestry machinery ; 52. Other special-purpose machinery; 53. General-purpose machinery ; 54. Bicycles and wheelchairs; 55. Other transport equipment and parts; 56. Transformers and parts thereof; 57. Other electrical machinery; 58. Radio, television and communication equipment and apparatus; 59. Iron, steel and their products; 60. Non-ferrous metals and their products

Sector 7. Chemicals: 61. Basic organic chemicals; 62. Basic inorganic chemicals; 63. Chemical fertilisers; 64. Organic fertilisers and other agricultural chemicals; 65. Pesticides; 66. Veterinary medicines; 67. Pharmaceutical products; 68. Rubber and rubber products; 69. Soap products; 70. Cleansers, perfumes and toiletries; 71. Plastics in primary forms; 72. Products from plastics; 73. Paints ; 74. Varnishes, colours, ink; 75. Other chemicals n.e.c.; 76. Petroleum oils and lubricants.

Sector 8. Textile, clothing and footwear: 77. Woven fabrics ; 78. Textile fibres and threads ; 79. Wearing apparel, except fur apparel; 80. Carpets, other textile floor coverings; 81. Other textile fabrics, n.e.c. ; 82. Tanned, dressed, composition leather; 83. Leather products.

Sector 9. Other manufacturing products: 84. Printing accessories and products; 85. Publishing activities and products; 86. Other manufactured products n.e.c.

Sector 10. Gas, electricity and water: 87. Electricity and gas generation and distribution; 88. Water extraction, refining and distribution.

Sector 11. Construction: 89. General construction services of residential and non-residential buildings; 90. Other construction services.

Sector 12. Trade and repair: 91. Wholesale and retail services; 92. Repairs of motorvehicles, domestic appliances and personal stuffs.

Sector 13. Hotels and restaurants: 93. Hotel and motel lodging services ; 94. Meal serving services.

Sector 14. Transport and communications: 95. Road transport and pipeline services; 96. Railway transport services; 97. Water transport services ; 98. Air transport services ; 99. Postal and telecommunication services; 100. Travel services.

Sector 15. Financial services: 101. Financial services; 102. Lottery and related services; 103. Insurance services.

Sector 16. Property and business services: 104. Research and development services; 105. Real estate services; 106. Other business services.

Sector 17. Public administration: 107.Public administration and compulsory social security services

Sector 18. Education: 108. Education and training services

Sector 19. Health care: 109. Human health service, Veterinary services, Social services

Sector 20. Other services: 110. Cultural and sporting services; 111. Services furnished by associations; 112. Other miscellaneous services; 113. Dwelling services.

A2. Qualifications

There are 6 qualifications in VNET, namely:

(1) No qualifications;
(2) Short-term vocational training;
(3) Long-term vocational training;
(4) Professional high school;
(5) College;
(6) University.

These qualifications correspond to those in the Vietnam Living Standard Surveys (VHLSS) for the year 2004 and 2006. As such, the category "No qualifications" may include people who have undergone training but received no formal certificates.

A3. Occupations

There are 26 occupations in VNET, which are aggregates from the 34 occupations in VHLSS 2004 and 2006. For this paper, we further aggregate them into 11 occupations. The concordances between the 11 occupations in this paper and the 34 occupations in VHLSS are as follows:

I. Leaders and executive managers
1. Communist Party offices of all levels
2. National Assembly and president's office
3. Central Government
4. People's Courts and People's Procuracies
5. People's councils and People's committees at local level
6. Mass organisations
7. Charity organisation and specific organisations for other purposes
8. Corporations, companies and equivalent which produce material goods and services
9. Firms, factories, manufacturers which create materials goods and services, and small schools

II. High-level professionals
10. High-level professionals - Natural and technical sciences
11. High-level professionals - Life and health sciences
12. High-level professionals- Education and training

13. High-level professionals- Others

III. Mid-level professionals

14. Mid-level professionals - Natural and technical sciences
15. Mid-level professionals - Life and health sciences
16. Mid-level professionals- Education and training
17. Mid-level professionals- Others

IV. Elementary professional and technicians

18. White-collar personnel
19. Customer service staff

V. Skilled workers in service and sales

20. Personal services and protection services
21. Modelers, salesmen, product introducers/marketers

VI. Skilled workers in agriculture, forestry, and aquaculture

22. Skilled workers in agriculture, forestry, and aquaculture

VII. Skilled craft and related trades workers

23. Skilled miners and builders
24. Metal workers, mechanical workers and other related workers
25. Workers who make sophisticated goods, handicraftsmen, printing workers, and other related workers
26. Food processing, woodworking, textile and garment, leather and shoemaking workers
27. Other handcraftsmen and workers related not elsewhere specified

VIII. Assemblers and machine operators

28. Production machine operators
29. Assemblers and machine operators
30. Drivers and operators of motorised equipment

IX. Unskilled workers in sales and services

31. Sale and service unskilled workers

X. Unskilled workers in agriculture, forestry, and aquaculture

32. Unskilled workers in agriculture, forestry, and aquaculture

XI. Unskilled workers in other industries, and armed force personnel

33. Unskilled workers in mining, construction, manufacturing, transportation industry, and other unskilled workers
34. Armed forces

Appendix 2. Industry Cost and Sale Structure in the year 2010

(Source: Vietnam Input-output data for the year 2005, GSO 2008b, updated with the current forecast)

Table A2.1. Factor shares in industry factor costs (%)

Sector	Labour	Capital	Land	Total
1. Agriculture and forestry	53.2	16.4	30.4	100.0
2. Fishery	45.4	26.1	28.6	100.0
3. Mining	27.9	28.8	43.2	100.0
4. Food, beverage and tobacco products	55.2	44.8	0.0	100.0
5. Non-metal products	45.2	54.8	0.0	100.0
6. Metals, machines and equipment	56.2	43.8	0.0	100.0
7. Chemicals	54.7	45.3	0.0	100.0
8. Textile, clothing and footwear	48.6	51.4	0.0	100.0
9. Other manufacturing products	46.5	53.5	0.0	100.0
10. Gas, electricity and water	46.7	53.3	0.0	100.0
11. Construction	53.0	47.0	0.0	100.0
12. Trade and repair	55.3	44.7	0.0	100.0
13. Hotels and restaurants	51.7	48.3	0.0	100.0
14. Transport and communications	46.0	54.0	0.0	100.0
15. Financial services	54.5	45.5	0.0	100.0
16. Property and business services	60.7	39.3	0.0	100.0
17. Public administration	87.4	12.6	0.0	100.0
18. Education	79.7	20.3	0.0	100.0
19. Health care	76.4	23.6	0.0	100.0
20. Other services	23.6	76.4	0.0	100.0
Economy-wide average	49.6	40.9	9.4	100.0

Table A2.2. Structure of industry costs (%)

Sector	Domestic intermediate inputs	Imported intermediate inputs	Margin	Taxes on intermediate inputs	Labour	Capital	Land	Production tax	Total
1. Agriculture and forestry	20.8	8.0	0.9	0.6	36.2	11.2	20.7	1.5	100.0
2. Fishery	22.8	20.4	1.2	0.6	24.5	14.1	15.4	1.0	100.0
3. Mining	13.1	13.9	0.8	1.4	15.6	16.1	24.2	14.8	100.0
4. Food, beverage and tobacco products	60.9	14.3	3.7	0.9	10.9	8.8	0.0	0.5	100.0
5. Non-metal products	41.7	30.7	2.3	-0.8	11.5	14.0	0.0	0.6	100.0
6. Metals, machines and equipment	25.1	49.7	4.0	-0.2	11.8	9.2	0.0	0.5	100.0
7. Chemicals	21.1	50.1	2.7	-0.3	14.2	11.8	0.0	0.5	100.0
8. Textile, clothing and footwear	34.2	47.3	2.3	-0.1	7.7	8.2	0.0	0.4	100.0
9. Other manufacturing products	40.0	34.3	3.2	0.3	10.1	11.6	0.0	0.5	100.0
10. Gas, electricity and water	11.3	22.8	1.4	-1.2	30.2	34.6	0.0	0.9	100.0
11. Construction	35.3	31.9	2.9	-0.3	15.5	13.8	0.0	0.9	100.0
12. Trade and repair	29.0	13.3	1.8	3.1	28.3	22.9	0.0	1.5	100.0
13. Hotels and restaurants	29.9	16.3	1.1	-0.6	27.3	25.5	0.0	0.5	100.0
14. Transport and communications	17.3	25.5	1.5	-0.8	25.4	29.8	0.0	1.3	100.0
15. Financial services	24.2	10.5	0.5	1.5	34.1	28.4	0.0	0.9	100.0
16. Property and business services	24.7	14.1	0.9	-0.1	34.3	22.2	0.0	3.9	100.0
17. Public administration	28.5	16.9	0.9	2.4	44.9	6.5	0.0	0.0	100.0
18. Education	18.7	12.6	0.8	1.6	52.6	13.4	0.0	0.3	100.0
19. Health care	18.5	21.9	3.1	2.4	41.0	12.6	0.0	0.5	100.0
20. Other services	12.3	7.6	0.6	0.8	18.3	59.2	0.0	1.1	100.0
Economy-wide average	29.9	25.2	2.1	0.4	20.1	16.6	3.8	1.8	100.0

Table A2.3. Structure of commodity sales (%)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sector	Intermediate inputs	Investment	Household consumption	Exports	Government consumption	Changes in inventories	Total	Import shares in local market
1. Agriculture and forestry	56.4	0.4	21.6	17.5	1.0	3.2	100.0	8.0
2. Fishery	41.8	0.0	41.3	16.1	0.0	0.8	100.0	2.4
3. Mining	11.5	0.0	0.5	87.5	0.3	0.2	100.0	41.9
4. Food, beverage and tobacco products	18.5	0.0	45.9	31.5	0.1	4.0	100.0	15.7
5. Non-metal products	74.0	0.9	5.1	18.5	1.0	0.5	100.0	28.0
6. Metals, machines and equipment	40.5	18.8	4.7	36.1	0.0	0.0	100.0	70.9
7. Chemicals	57.0	0.0	26.1	17.8	0.0	-0.9	100.0	71.6
8. Textile, clothing and footwear	22.4	1.2	5.9	74.4	0.0	-3.9	100.0	62.2
9. Other manufacturing products	67.9	1.8	12.5	19.5	0.5	-2.2	100.0	22.5
10. Gas, electricity and water	92.0	0.0	8.0	0.0	0.0	0.0	100.0	0.5
11. Construction	0.9	97.6	0.0	0.0	1.6	0.0	100.0	-
12. Trade and repair	79.0	0.0	12.7	8.3	0.0	0.0	100.0	0.5
13. Hotels and restaurants	16.9	0.0	58.0	25.1	0.0	0.0	100.0	16.2
14. Transport and communications	34.5	20.6	27.7	16.6	0.6	0.0	100.0	16.9
15. Financial services	50.9	2.3	31.0	15.8	0.0	0.0	100.0	43.3
16. Property and business services	73.7	0.0	7.0	5.2	14.1	0.0	100.0	5.3
17. Public administration	0.3	0.0	0.0	0.0	99.7	0.0	100.0	-
18. Education	13.3	0.0	12.8	2.4	71.5	0.0	100.0	17.1
19. Health care	5.3	0.0	47.9	7.3	39.4	0.0	100.0	19.0
20. Other services	1.4	0.0	88.0	4.9	5.7	0.0	100.0	9.0
Economy-wide average	32.0	13.9	20.5	27.4	5.9	0.4	100.0	

Appendix 3. Structure of Employment (by hours) in the year 2010.

(Source: Authors' calculations from the number of working hours in the main and the second jobs, average of VHLSS 2004 and VHLSS 2006)

Table A3.1. Qualification composition of occupation-specific employment (%)

Qualification	1.Leaders and managers	2.High-level professionals	3.Mid-level professionals	4.Elementary professionals and technicians	5.Skilled workers in services and sales	6.Skilled workers in agriculture	7.Skilled handicraftsmen and manual workers	8.Assemblers and machine operators	9.Unskilled workers in sales and services	10. Unskilled workers in agriculture	11. Other Unskilled workers	Economy-wide
1.No qualifications	43.4	1.6	11.9	44.7	74.0	85.8	78.9	50.0	88.4	96.3	94.3	72.0
2.Short-term vocational training	2.7	0.1	3.0	9.4	8.3	3.6	9.7	22.8	3.0	1.1	2.1	4.8
3.Long-term vocational training	2.5	0.2	3.9	3.9	3.5	1.9	4.4	14.6	1.2	0.5	0.8	2.5
4.Professional high school	18.8	1.9	53.7	19.5	8.1	5.4	4.8	9.0	4.1	1.7	2.2	7.2
5.College	1.8	6.6	14.9	1.9	1.1	0.3	1.5	1.0	0.7	0.2	0.1	2.1
6.University	30.7	89.5	12.6	20.6	4.9	3.0	0.8	2.7	2.6	0.2	0.4	11.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table A3.2. Occupation composition of skill-specific employment (%)

Qualification	1.Leaders and managers	2.High-level professionals	3.Mid-level professionals	4.Elementary professionals and technicians	5.Skilled workers in services and sales	6.Skilled workers in agriculture	7.Skilled handicraftsmen and manual workers	8.Assemblers and machine operators	9.Unskilled workers in sales and services	10. Unskilled workers in agriculture	11. Other Unskilled workers	Total
1.No qualifications	1.6	0.2	0.9	1.3	5.7	3.3	21.4	3.0	16.8	32.1	13.7	100.0
2.ST vocational training	1.6	0.3	3.6	4.0	9.7	2.1	39.6	20.7	8.7	5.3	4.6	100.0
3.LT vocational training	2.8	0.6	8.7	3.2	7.9	2.2	34.4	25.6	6.6	4.7	3.4	100.0
4.Professional high school	7.1	2.5	41.7	5.4	6.2	2.1	12.9	5.4	7.8	5.5	3.3	100.0
5.College	2.3	29.3	39.5	1.8	2.9	0.4	14.0	2.0	4.3	2.8	0.7	100.0
6.University	7.3	73.4	6.2	3.6	2.4	0.7	1.3	1.0	3.1	0.5	0.4	100.0
Economy-wide average	2.7	9.4	5.6	2.0	5.5	2.8	19.6	4.4	13.7	24.0	10.4	100.0

Table A3.3. Industry composition of occupation-specific employment (%)

Sector	1.Leaders and managers	2.High-level professionals	3.Mid-level professionals	4.Elementary professionals and technicians	5.Skilled workers in services and sales	6.Skilled workers in agriculture	7.Skilled handicraftsmen and manual workers	8.Assemblers and machine operators	9.Unskilled workers in sales and services	10. Unskilled workers in agriculture	11. Other Unskilled workers	Economy-wide
1.Agriculture and forestry	1.2	1.0	1.7	1.9	1.9	67.6	0.3	2.9	2.4	88.1	1.9	24.0
2.Fishery	1.7	-	0.1	1.3	0.8	29.0	0.1	0.5	0.4	11.3	0.4	3.8
3.Mining	2.2	3.8	2.4	1.6	1.6	0.1	2.3	3.6	0.0	0.0	3.0	1.6
4.Food, beverages and tobacco	2.3	1.8	1.1	2.8	0.6	1.1	19.3	13.7	1.0	0.2	17.6	6.8
5.Non-metal products	1.8	1.8	1.3	2.2	1.0	-	7.8	5.2	0.7	0.0	14.8	3.8
6.Metals, machines and equipment	3.4	5.6	5.2	4.1	1.2	-	9.7	17.2	0.2	0.0	3.3	4.1
7.Chemicals	1.6	6.4	3.4	2.1	1.8	0.1	4.0	5.6	0.6	-	5.8	2.7
8.Textile, clothing and footwear	0.2	0.5	0.5	2.1	0.4	-	19.9	3.6	0.2	0.1	3.1	4.6
9.Other manufacturing	0.3	0.7	1.8	1.3	-	-	3.2	1.1	0.9	0.0	4.7	1.5
10.Gas, electricity and water	1.1	8.3	5.6	9.1	2.1	0.4	2.0	12.2	0.6	-	1.1	2.5
11.Construction	2.7	3.7	2.0	0.9	1.6	-	23.8	5.2	0.2	0.0	23.9	8.1
12.Trade and repair	1.8	2.0	1.7	2.9	34.4	0.0	2.6	3.3	44.9	0.1	1.6	9.3
13.Hotels and restaurants	0.6	0.4	0.2	2.1	12.3	0.1	1.0	0.0	20.0	0.0	0.3	3.8
14.Transport and communications	1.5	6.8	2.8	20.4	1.9	0.2	0.3	18.8	1.6	0.0	5.8	3.1
15.Financial services	1.6	3.2	1.5	7.8	2.6	-	-	0.1	0.7	-	0.2	0.9
16.Property and business services	3.9	12.1	5.2	8.6	10.9	0.0	1.2	2.9	5.2	-	0.6	3.4
17.Public administration	59.6	13.6	11.2	20.4	6.3	0.5	0.6	2.7	0.3	0.0	0.7	4.7
18.Education	2.7	18.8	30.7	1.9	2.6	-	0.1	0.3	0.6	0.0	0.5	3.9
19.Health care	1.1	6.7	18.9	1.2	2.0	0.3	0.0	0.2	0.4	0.0	0.3	2.0
20.Other services	8.6	2.7	2.4	5.4	14.2	0.5	1.9	1.0	19.0	0.2	10.4	5.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table A3.4. Occupation composition of industry-specific employment (%)

Sector	1.Leaders and managers	2.High-level professionals	3.Mid-level professionals	4.Elementary professionals and technicians	5.Skilled workers in services and sales	6.Skilled workers in agriculture	7.Skilled handicraftsmen and manual workers	8.Assemblers and machine operators	9.Unskilled workers in sales and services	10. Unskilled workers in agriculture	11. Other Unskilled workers	Economy-wide
1.Agriculture and forestry	0.1	0.4	0.4	0.2	0.4	7.8	0.3	0.5	1.4	87.7	0.8	100.0
2.Fishery	1.3	-	0.2	0.7	1.1	21.3	0.7	0.5	1.4	71.7	1.0	100.0
3.Mining	3.9	21.9	8.4	2.0	5.5	0.2	28.2	9.7	0.4	0.0	19.7	100.0
4.Food, beverages and tobacco	1.0	2.5	0.9	0.8	0.5	0.5	55.5	8.7	2.0	0.6	27.0	100.0
5.Non-metal products	1.3	4.5	2.0	1.2	1.5	-	40.3	5.9	2.6	0.0	40.7	100.0
6.Metals, machines and equipment	2.4	12.9	7.1	2.0	1.6	-	46.6	18.4	0.5	0.0	8.3	100.0
7.Chemicals	1.7	22.4	7.1	1.6	3.8	0.1	28.7	9.1	3.0	-	22.4	100.0
8.Textile, clothing and footwear	0.1	1.1	0.6	0.9	0.4	-	85.5	3.4	0.6	0.3	7.1	100.0
9.Other manufacturing	0.6	4.6	6.6	1.7	-	-	41.8	3.2	8.3	0.2	33.0	100.0
10.Gas, electricity and water	1.2	30.6	12.2	7.2	4.6	0.4	15.6	20.7	3.0	-	4.5	100.0
11.Construction	1.0	4.4	1.4	0.2	1.1	-	57.8	2.8	0.4	0.1	30.9	100.0
12.Trade and repair	0.5	2.0	1.0	0.6	20.6	0.0	5.4	1.5	66.2	0.2	1.8	100.0
13.Hotels and restaurants	0.5	0.9	0.3	1.1	18.2	0.1	5.1	0.0	72.9	0.1	0.8	100.0
14.Transport and communications	1.4	20.7	5.2	13.5	3.4	0.2	1.7	26.7	7.3	0.1	19.8	100.0
15.Financial services	5.2	34.6	9.9	18.6	16.9	-	-	0.6	11.4	-	2.7	100.0
16.Property and business services	3.2	32.9	8.5	5.1	17.7	0.0	6.7	3.6	20.5	-	1.7	100.0
17.Public administration	35.7	27.2	13.3	8.8	7.5	0.3	2.4	2.5	0.8	0.0	1.5	100.0
18.Education	1.9	45.1	43.9	1.0	3.8	-	0.3	0.3	2.3	0.0	1.4	100.0
19.Health care	1.6	32.0	53.6	1.2	5.6	0.5	0.3	0.5	3.0	0.1	1.7	100.0
20.Other services	4.2	4.5	2.3	1.9	13.9	0.2	6.5	0.8	45.9	0.8	19.0	100.0
Total	2.8	9.4	5.6	2.0	5.6	2.8	19.5	4.3	13.7	23.9	10.4	100.0

Appendix 4. Number of working hours and wage rate, by qualification

Table A4.1. Number of working hours and wage rate, by qualification

Qualification	Hours per person per year (hrs)	Wage bill per person per year (VND mil)
1. No qualifications	1,632.7	6.93
2. Short-term vocational training	2,276.2	14.01
3. Long-term vocational training	2,753.6	18.05
4. Professional high school	2,969.0	21.45
5. College	2,632.7	18.89
6. University	4,088.8	45.54

(Source: Author's calculation from VHLSS2004 and VHLSS 2006)

Appendix 5. Shocks at the industries and commodities level in the forecast simulation

Table A5.1. Changes to technology and tastes for aggregated 20 sector.

	(1)	(2)	(3)	(4)
Sector	Primary factor augmenting technical change[(a)]	Commodity preference in production[(b)]	Household preference[(c)]	Changes in tariff rate[(d)]
1. Agriculture and forestry	-1.47	-0.21	-1.78	0
2. Fishery	-1.76	-0.53	1.50	0
3. Mining	-1.78	0.42	0.00	0
4. Food, beverage and tobacco products	-1.13	0.82	0.12	-0.478
5. Non-metal products	-0.62	1.89	1.17	-0.358
6. Metals, machines and equipment	-0.62	1.71	1.84	-0.560
7. Chemicals	-0.68	1.17	2.37	-0.440
8. Textile, clothing and footwear	-0.65	1.28	-0.62	-0.144
9. Other manufacturing products	-0.62	1.26	0.81	-1.001
10. Gas, electricity and water	-0.62	1.54	2.23	0
11. Construction	0.00	0.00	0.00	0
12. Trade and repair	0.00	0.00	-3.76	0
13. Hotels and restaurants	-0.62	0.79	2.26	0
14. Transport and communications	-0.62	1.14	2.47	0
15. Financial services	-2.48	1.31	2.69	0
16. Property and business services	-1.32	1.25	0.75	0
17. Public administration	0.00	-0.79	0.00	0
18. Education	-1.24	0.79	1.50	0
19. Health care	-0.62	0.79	1.50	0
20. Other services	-0.45	-0.79	1.04	0
Economy-wide average	-0.87	1.18	0.88	-0.406

(Source: (a) – (c) Authors' calculations based on historical data; (d) Authors' calculation based on Vietnam's WTO commitments. Note that for (a), negative numbers mean technical progress, because fewer factor inputs are needed to produce the same outputs.)

Table A5.2. Annual average change in occupation-specific input requirement (Occupational twists)

Occupation	Occupational twist
1. Leaders and managers	4.86
2. High-level professionals	10.47
3. Mid-level professionals	3.64
4. Elementary professionals and technicians	-2.13
5. Skilled workers in services and sales	5.99
6. Skilled workers in agriculture	3.03
7. Skilled handicraftsmen and manual workers	10.07
8. Assemblers and machine operators	5.77
9. Unskilled workers in sales and services	3.91
10. Unskilled workers in agriculture	-5.74
11. Other Unskilled workers	0.00

(Source: Authors' calculation from changes in the number of working hours and the wage rates by occupation and industry in VHLSS 2004 and VHLSS 2006)

Table A5.3. Changes to agricultural land

Indicators	Unit	Rice land[(a)]	Agricultural land[(b)]	Non-rice agricultural land[(c)]
Area in 2000	(thous ha)	4,467.8	9,345.4	4,877.6
Area in 2009	(thous ha)	4,089.1	9,598.8	5,509.7
Annual change 2000-2009	(%)	-0.98	0.30	1.36
Calculated area in 2010	(thous ha)	4,049.0	9,627.4	5,584.8
Planned for 2020, no climate change	(thous ha)	3,632.7	8,998.8	5,366.1
Proportion of expected inundated area	(%)	0.140	0.098	
Estimated area in 2020, with climate change	(thous ha)	3,615.1	8,990.0	5,374.9
Percentage changes during 2006-2010	2005-2010	-4.802	1.497	7.004
Percentage changes during 2011-2020	2010-2020	-10.717	-6.621	-3.759

(Note: (a) and (b): from NIAPP(2010) "Policy research on Vietnam's food security and rice value chain dynamics", Hanoi; (c) Calculated as a difference between agricultural land and rice land.)

Appendix 6. Detailed decomposition results for employment by 25 occupations, 2010-2020 (percentage change)

	Occupation	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	Total	Annual average
1	**Leaders and managers**	**1.4**	**18.1**	**7.1**	**-12.4**	**6.2**	**-0.3**	**0.9**	**-0.1**	**4.8**	**0.0**	**1.8**	**27.5**	**2.5**
	High-level professionals	**0.3**	**40.7**	**0.9**	**26.4**	**16.6**	**1.1**	**1.0**	**0.1**	**0.9**	**0.0**	**0.3**	**88.4**	**6.5**
2	HLP - Natural and technical sciences	1.7	45.5	-2.7	29.7	18.9	1.3	1.4	0.4	-2.3	0.0	-1.1	92.8	6.8
3	HLP - Life and health sciences	0.7	41.7	0.3	23.1	17.0	2.0	2.6	0.0	0.5	0.0	1.0	88.8	6.6
4	HLP- Education and training	-6.4	29.0	8.1	23.2	11.6	0.3	1.2	-0.2	7.2	0.0	2.5	76.5	5.8
5	HLP- Others	1.8	42.1	0.3	26.6	17.2	1.1	0.5	0.2	0.3	0.0	0.1	90.2	6.6
	Mid-level professionals	**-0.7**	**12.5**	**3.0**	**-22.5**	**6.9**	**1.0**	**1.0**	**0.1**	**2.4**	**0.0**	**0.9**	**4.5**	**0.4**
6	MLP - Natural and technical sciences	0.0	15.4	0.7	-20.7	9.8	0.6	0.3	0.3	0.3	-0.1	-0.3	6.5	0.6
7	MLP - Life and health sciences	-0.4	10.7	2.5	-22.8	6.4	2.0	1.7	0.1	1.4	0.0	1.2	2.7	0.3
8	MLP- Education and training	-4.3	11.2	5.7	-28.3	5.5	0.6	1.1	-0.1	5.1	0.0	1.8	-1.8	-0.2
9	MLP- Others	1.5	13.2	2.1	-18.9	7.2	1.0	0.8	0.1	1.5	0.0	0.4	9.0	0.9
	Elementary professionals and technical personnel	**0.0**	**13.7**	**1.6**	**-57.5**	**5.7**	**2.1**	**0.7**	**0.1**	**0.7**	**0.0**	**0.4**	**-32.6**	**-3.9**
10	White-collar personnel	0.7	11.9	2.9	-54.9	4.0	1.0	0.6	0.1	1.8	0.0	0.6	-31.2	-3.7
11	Customer service staff	-0.8	15.8	0.0	-60.8	7.8	3.4	0.8	0.2	-0.7	0.0	0.2	-34.2	-4.1
	Skilled workers in personal services,	**-1.8**	**16.7**	**3.6**	**13.8**	**5.0**	**2.6**	**0.1**	**0.3**	**-0.3**	**0.0**	**0.5**	**40.6**	**3.5**
12	Personal services and protection services	0.1	15.0	0.8	11.2	5.1	2.7	1.0	0.3	0.8	0.0	0.8	37.7	3.3
13	Modellers, salesmen, product marketers	-3.9	18.5	6.7	16.6	5.0	2.6	-0.8	0.3	-1.5	0.0	0.3	43.8	3.7
14	**Skilled workers in agriculture**	**3.0**	**18.8**	**-10.5**	**69.9**	**1.3**	**-3.4**	**-3.5**	**-0.6**	**-1.1**	**0.0**	**-0.8**	**73.0**	**5.6**
	Skilled handicraftsmen and manual workers	**-2.2**	**16.1**	**4.6**	**26.1**	**5.0**	**0.8**	**0.5**	**0.4**	**-0.8**	**0.0**	**-0.5**	**50.1**	**4.1**
15	Skilled miners and builders	-7.7	12.1	7.5	30.4	5.2	1.1	1.4	0.2	-0.5	0.0	1.0	50.8	4.2
16	Metal workers, mechanical workers & related workers	1.5	15.6	2.2	-0.3	11.4	1.3	2.4	0.7	-0.9	-0.2	-1.3	32.4	2.8
17	Handicraftsmen, printing workers & related workers	-2.1	13.4	1.0	-29.8	4.1	0.9	2.3	0.4	-0.3	0.0	-0.1	-10.3	-1.1
18	Food, wood, textile, clothing and footwear workers	0.8	20.1	3.6	41.7	3.2	0.4	-1.1	0.5	-1.0	0.1	-1.5	66.7	5.2
19	Other handicraftsmen and related workers, nec.	0.4	14.6	1.3	-24.2	4.7	1.6	2.1	0.5	-0.6	0.0	-0.4	-0.1	0.0
	Assemblers and machine operators	**-0.6**	**13.5**	**-0.9**	**6.0**	**9.2**	**-0.8**	**1.8**	**0.2**	**-0.5**	**0.0**	**-0.5**	**27.4**	**2.5**
20	Production machine operators	-1.4	16.3	0.2	4.5	5.1	-4.1	1.1	0.5	-0.9	0.0	-0.5	20.7	1.9
21	Assemblers and machine operators	3.9	16.9	-1.0	1.1	9.9	1.3	4.4	0.6	-0.9	-0.1	-1.2	34.9	3.0
22	Drivers and operators of motorised equipment	-2.3	10.4	-1.4	9.0	11.2	0.0	1.0	0.0	-0.1	0.0	-0.1	27.6	2.5
23	**Sale and service unskilled workers**	**-2.4**	**16.3**	**3.2**	**0.8**	**2.6**	**2.8**	**-0.2**	**0.3**	**-1.0**	**0.0**	**0.4**	**22.7**	**2.1**
24	**Unskilled workers in agriculture, forestry,**	**3.7**	**12.1**	**-8.1**	**-14.7**	**-1.1**	**-3.8**	**-2.0**	**-0.7**	**-0.5**	**0.0**	**-0.5**	**-15.6**	**-1.7**
25	**Other unskilled workers**	**-2.2**	**11.6**	**0.9**	**-40.0**	**1.0**	**0.7**	**1.4**	**0.2**	**-0.4**	**0.0**	**0.1**	**-26.6**	**-3.1**

Appendix 7. Decomposition of changes in the composition of employment, 2011 – 2020

This appendix reports forecast changes in employment (hours) shares by 20 aggregate industry, 11 aggregate occupations, and 6 qualification levels from 2010 to 2020, and decomposes the change in shares to different groups of exogenous shocks.

Table A7.1: Decomposition of changes in industry structure of employment, 2011-2020 (%)

		Change in share due to											
Sector	**Share in 2010**	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	**Share in 2020**
1. Agriculture and forestry	**24.00**	1.46	-1.01	-2.40	1.58	-1.31	-1.27	-0.47	-0.24	-0.09	-0.00	-0.12	**20.01**
2. Fishery	**3.77**	-0.29	-0.01	-0.13	0.02	-0.08	0.17	-0.18	0.04	-0.05	0.01	-0.04	**3.10**
3. Mining	**1.61**	0.27	0.06	-0.29	-0.20	0.12	-0.01	-0.09	0.01	-0.03	0.00	-0.04	**1.51**
4. Food, beverage and tobacco products	**6.79**	-0.31	-0.33	-0.39	-0.03	-0.20	-0.20	0.03	-0.05	-0.08	-0.00	0.02	**5.72**
5. Non-metal products	**3.79**	0.12	0.10	-0.24	0.10	0.07	0.03	0.12	0.02	-0.03	0.00	-0.03	**3.78**
6. Metals, machines and equipment	**4.05**	0.21	0.44	-0.04	-0.04	0.43	0.06	0.18	0.05	-0.09	-0.01	-0.11	**5.09**
7. Chemicals	**2.69**	0.15	0.30	-0.19	-0.14	0.19	0.12	0.23	0.02	-0.07	-0.01	-0.03	**3.04**
8. Textile, clothing and footwear	**4.55**	0.06	0.09	0.91	0.02	-0.05	0.02	-0.18	0.08	-0.01	0.02	-0.15	**5.44**
9. Other manufacturing products	**1.50**	-0.02	0.06	0.03	0.08	0.03	0.02	0.04	0.01	-0.01	-0.00	-0.01	**1.68**
10. Gas, electricity and water	**2.55**	0.25	0.22	-0.04	-0.15	0.17	0.03	0.03	0.01	-0.05	0.00	-0.02	**2.90**
11. Construction	**8.05**	-0.81	-0.49	0.84	-0.10	-0.05	0.09	0.15	0.00	-0.02	-0.00	0.11	**7.73**
12. Trade and repair	**9.30**	-0.55	-0.14	1.13	-0.04	-0.05	0.13	-0.11	0.02	-0.13	0.01	0.03	**10.19**
13. Hotels and restaurants	**3.75**	-0.00	0.04	-0.22	0.08	-0.03	0.33	-0.02	0.02	-0.06	-0.00	0.01	**4.06**
14. Transport and communications	**3.06**	-0.17	0.16	-0.03	-0.17	0.18	0.15	-0.00	0.00	-0.06	0.00	0.00	**2.97**
15. Financial services	**0.86**	-0.02	0.14	-0.08	-0.09	0.09	0.06	0.06	0.00	-0.03	0.00	-0.00	**0.97**
16. Property and business services	**3.44**	-0.08	0.26	0.07	-0.32	0.20	0.00	-0.02	0.01	-0.01	0.00	0.00	**3.47**
17. Public administration	**4.70**	0.19	-0.10	0.75	-0.27	0.03	0.01	0.09	-0.02	0.53	-0.00	0.17	**5.89**
18. Education	**3.90**	-0.24	0.08	0.30	-0.27	0.14	0.03	0.06	-0.01	0.26	-0.00	0.09	**4.31**
19. Health care	**1.97**	-0.03	0.09	0.09	-0.15	0.10	0.04	0.03	0.00	0.04	-0.00	0.04	**2.12**
20. Other services	**5.68**	-0.20	0.04	-0.06	0.10	0.01	0.19	0.07	0.02	-0.03	-0.00	0.07	**6.01**
Total	**24.00**	1.46	-1.01	-2.40	1.58	-1.31	-1.27	-0.47	-0.24	-0.09	-0.00	-0.12	**20.01**

Table A7.2: Decomposition of changes in occupation structure of employment, 2011-2020 (%)

Occupation	**Share in 2010**	Change in share due to: Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	**Share in 2020**
1. Leaders and managers	**2.81**	0.04	0.03	0.20	-0.35	0.06	-0.01	0.03	-0.00	0.14	-0.00	0.05	**2.99**
2. High-level professionals	**9.37**	0.04	1.91	0.10	2.45	1.13	0.11	0.10	0.01	0.10	-0.00	0.03	**14.67**
3. Mid-level professionals	**5.57**	-0.03	-0.20	0.18	-1.27	0.15	0.06	0.06	0.01	0.14	-0.00	0.05	**4.84**
4. Elementary professionals and technicians	**2.03**	0.00	-0.05	0.03	-1.17	0.03	0.04	0.02	0.00	0.02	-0.00	0.01	**1.14**
5. Skilled workers in services and sales	**5.57**	-0.09	-0.01	0.21	0.76	0.05	0.15	0.01	0.02	-0.01	0.00	0.03	**6.53**
6. Skilled workers in agriculture	**2.77**	0.09	0.05	-0.29	1.93	-0.08	-0.09	-0.10	-0.02	-0.03	0.00	-0.02	**4.00**
7.Skilled craft and trades workers	**19.55**	-0.41	-0.12	0.93	5.06	0.16	0.18	0.11	0.08	-0.12	0.01	-0.09	**24.07**
8. Assemblers and machine operators	**4.34**	-0.02	-0.12	-0.03	0.25	0.21	-0.03	0.08	0.01	-0.02	-0.00	-0.02	**4.62**
9. Unskilled workers in sales and services	**13.69**	-0.31	-0.06	0.45	0.07	-0.20	0.40	-0.02	0.04	-0.12	0.00	0.06	**14.00**
10. Unskilled workers in agriculture	**23.89**	0.91	-0.96	-1.90	-3.55	-1.20	-0.89	-0.46	-0.17	-0.09	-0.00	-0.11	**16.79**
11. Other Unskilled workers	**10.41**	-0.22	-0.46	0.11	-4.17	-0.31	0.08	0.16	0.02	-0.02	-0.00	0.01	**6.36**
Total	**100.00**	-0.00	0.00	0.00	0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	-0.00	**100.00**

Table A7.2: Decomposition of changes in occupation structure of employment, 2011-2020 (%)

		Change in share due to											
Qualification	**Share in 2010**	Technical change	Aggregate employment growth	Foreign trading environment	Occupation-specific input requirements	Training	Household preferences	Import-domestic preferences	Agricultural land supply	Government spending	Import tariffs	Momentum	**Share in 2020**
1. No qualifications	**71.98**	0.00	-0.89	0.00	0.00	-6.09	0.00	0.00	0.00	0.00	0.00	0.00	**65.79**
2. Short-term vocational training	**4.78**	0.00	-1.22	0.00	0.00	2.31	0.00	0.00	0.00	0.00	0.00	0.00	**5.59**
3. Long-term vocational training	**2.48**	0.00	-0.65	0.00	0.00	1.05	0.00	0.00	0.00	0.00	0.00	0.00	**2.76**
4. Professional high school	**7.22**	0.00	-0.92	0.00	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	**6.66**
5. College	**2.12**	0.00	-0.01	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	**2.30**
6. University	**11.43**	0.00	3.69	0.00	0.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00	**16.91**
Total	**100.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**100.00**