The Puzzle of Educated Unemployment in West Africa[*]

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Abstract

Unemployment rates in urban West Africa are increasing or hump-shaped in education. This is puzzling because educated workers could downgrade to low-skilled self-employed jobs to escape unemployment. We argue that the public sector plays a role in this pattern and study how recent public policies affect (educated) unemployment, worker allocation across sectors and incomes. To this end we develop a search and matching model with heterogeneous workers who participate in a labour market with three sectors (public, private-formal and self-employment). We estimate the model using data from the West African 1-2-3-Survey. Low job arrival rates, low search efficiency when self-employed, and differential job destruction explain a large part of educated unemployment, while public sector wage distortions are relatively small. Public sector vacancy creation crowds out the private-formal sector, pushes workers into unemployment and self-employment, and benefits those with high education at the expense of those with little or no education. Indirect labour market policies such as subsidies to private-formal vacancy posting and facilitating entry into self-employment effectively decrease unemployment, have a positive impact on incomes, and are more egalitarian. These later policies should be preferred over public vacancy creation.

JEL: J24, J64, E24

Keywords: Unemployment, education, search and matching model, urban West Africa

1 Introduction

Unemployment rates are decreasing in educational attainment in most developed countries. This contrasts sharply with the phenomenon of *educated unemployment* observed in many developing countries. In these countries, workers with intermediate or advanced education are more likely to find themselves in unemployment than workers with basic or no education. The phenomenon is hotly debated by media and policy makers in developing countries, yet it has received little attention in the economics literature so far.

A region where educated unemployment is particularly pronounced is Francophone West Africa.[1] In several urban areas of the region, the unemployment rate of workers with intermediate education (i.e. secondary) is higher than the rate of workers without education (see Figure 1).
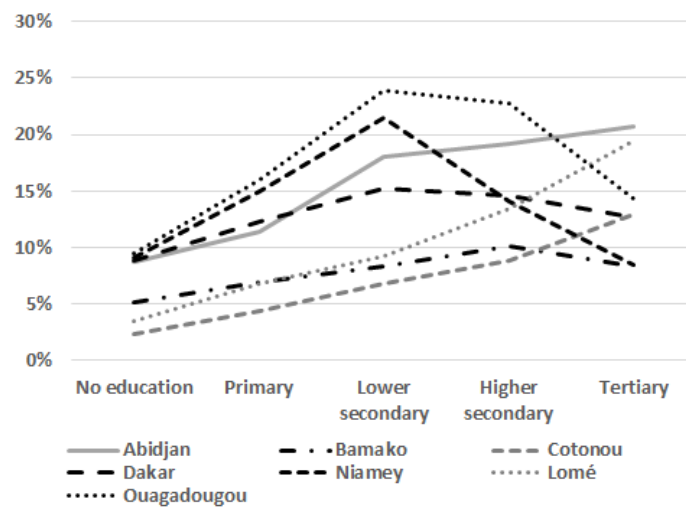
Sources: 1-2-3-Survey, 1st phase, 2001/2002; AFRISTAT, DIAL, INS; authors' calculations.

Figure 1: Unemployment rates of men (25 to 64 years old) in urban West Africa by education

Policy makers in Francophone West Africa recognise that unemployment is a major problem in the region and advocate an active role of the government, not least because educated unemployment has been suggested as one of the main causes of the recent upheavals in North Africa.[2] Against this background, the respective governments have actively intervened on the labour market in recent years (or plan to do so) using the following policies:

1. *Employment creation plans* that imply large recruitment programs in the public sector.[3]

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[1] According to ILO statistics (year in parenthesis), educated unemployment is also prevalent in Argentina (2014), Bangladesh (2013), Bolivia (2015), Brazil (2009), Botswana (2010), Colombia (2013), Egypt (2005), Ethiopia (2012), Malawi (2013), Morocco (2012), South Africa (2016), Vietnam (2014), Uganda (2012), Yemen (2014), and many other countries.

[2] For example, the communication of the Ivorian Ministerial Council of April, 8 2015 states the following: "La question de l'emploi est aujourd'hui une des problématiques les plus importantes qui reste à régler par le gouvernement." (The question of employment is today one of the most important problematic that remains to be solved by the government.) On the link between educated unemployment and the Arab Spring, see Campante and Chor (2012).

[3] Benin has set the target of 500,000 jobs over the period 2016 to 2021, Côte d'Ivoire of 2,000,000 jobs per year between 2012 and 2017, Niger of 200,000 between 2011 and 2015, and Senegal of 500,000 between 2012 and 2019. In Niger, President Issoufou reported that between 2011 and 2014, 87,000 permanent employments have been created in the country, among them 47,000 in the public sector. In Mali, the government reported 207,254 jobs created in the country over the period from 2013 to 2017, among them 107,114 job creations in the public sector. (All media

2. *Creation of employment agencies* to act as meeting platform for employers and employees and, thus, increase search efficiency and reduce recruitment costs.[4]

3. *Strategies to encourage self-employment* by directly or indirectly subsidizing entrepreneurial projects.[5]

However, the (large) public sector in Francophone West Africa might contribute to the problem rather than helping to resolve it. First, the prospect of public employment, which entails high job stability and high wages, raises workers' reservation wage and renders other employment opportunities (such as self-employment) less attractive.[6] Second, the economic literature has documented the possibility that a large public sector crowds out private sector vacancies, by imposing a negative externality (see Burdett (2012)).

The main objectives of this paper are twofold: First, we identify possible mechanisms explaining the phenomenon of educated unemployment in Francophone West Africa and quantify their respective contribution. More specifically, we analyse the role of the public sector (by paying public wage premia) and compare it to the role of other frictions in explaining educated unemployment and the missing downgrading to low-skilled jobs (i.e. self-employment) to escape unemployment. Second, we evaluate and contrast the impact of different public policies on the equilibrium in the labour market, in particular, their effect on (educated) unemployment, worker allocation across sectors and incomes.

We start by presenting stylized facts about the labour markets in urban Francophone West Africa. The largest employment sector is the informal/self-employment sector. Public administration and public enterprises provide close to half of all formal employments. There is an important sorting across sectors with respect to education, with low-educated workers being over-represented in self-employment. Unemployment rates are hump-shape or increasing in education, even after controlling for a large battery of observable characteristics. Finally, we document low transition rates across sectors on average, but substantial heterogeneity across education groups. These stylized facts inform our modeling decision.

We develop and estimate a search- and matching model with a labour market that consists of a public sector, firms in a private-formal sector and self-employment. We model the private-formal sector like the firm side in the Diamond-Mortensen-Pissardies model (see Pissarides (2000)). The

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sources are collected in Appendix F.)

[4]Examples include Benin, Côte d'Ivoire and Senegal.

[5]For example, in Benin, the Agence Nationale Pour l'Emploi, in collaboration with the World Bank, financed 8,500 micro-enterprises in 2017. In Côte d'Ivoire, the Ministère de la Promotion de l'emploi des jeunes announced loans for 7,200 entrepreneurial projects in 2015.

[6]Two real-life examples help to illustrate this point: freshly elected as Senegalese Head of State, President Sall announced the opening of 5,500 jobs in the public sector in December 2012. In February 2013, due to the large number of application, the second largest football stadium of the capital city was opened to register applicants. By mid-March 2013, an estimated 115,000 applications had been received by the Senegalese public administration and 10,000 more were expected until the end of the month. In the same month of March, 48 upper-secondary-graduates of the Centre National de Formation des Techniciens en Agriculture organized a 450 Km-protest march followed by a hunger strike. Deeply worried about their employment prospects, they demanded to be recruited by the Senegalese public administration. The 48-hunger-strikers abandoned their demand because they were promised public support for starting entrepreneurial projects. Source: *Le journal de l'économie Sénégalaise*, July 2013.

public sector in our model posts an exogenous amount of vacancies and pays wages according to an exogenous wage rule, including a public-sector wage premium. Given that the public sector hires on the same labour market as the private-formal sector, changes in public vacancies or wages directly affect the private-formal sector. In contrast, business ideas (i.e. self-employment opportunities) arise independently of the state of the public/formal-private labour market. We allow self-employed workers to continue receiving offers from the public and private-formal sector, though at a lower rate. Matches in all sectors get destroyed at an exogenous rate. On the worker side, we assume heterogeneous individuals. As sectoral productivity and destruction rates differ by education, heterogeneous workers sort along education into different sectors of the labour market.

We use our framework to decompose educated unemployment and to simulate the effect of different counterfactual labour market and education policy reforms. In the first part, the decomposition of educated unemployment reveals that high frictions in the labour market (i.e. high vacancy creation costs) and differential job destruction are the main determinants of educated unemployment. Interestingly, the distortion entailed by public wage premia is relatively small. Public wage premia are large for those education groups who are not likely to work in the public sector, and small for the other ones, leading to (generally) small distortionary effects. Hence, the contribution of public wage premia to educated unemployment is only minor.

In the second part, we simulate the impact of several public policies which have been envisaged or implemented by West African governments in the recent past. These policies are namely: (i) public sector vacancy creation, (ii) reducing vacancy posting cost, (iii) direct and indirect subsidies to entrepreneurial projects, and (iv) an education reform. The first three policies are specifically targeted at the labour market. The last one is part of a more general development strategy, as spelled in the Millenium Development Goals 2015.[7] First, we analyse the impact of doubling public sector vacancies. An increase in public sector vacancies has the unintended effect of increasing overall unemployment. In fact, more public sector vacancies crowd out private-formal sector vacancies, translating into a drop in the offer rate. Moreover, the policy has important redistributive effects. Workers with lower secondary education and less see their unemployment rates rise (because of fewer private-formal offers), while workers with tertiary education benefit from more public employment. In contrast, indirect labour market policies, such as subsidising private-formal vacancy posting or lowering barriers to self-employment, effectively lower unemployment. Furthermore, they achieve this in a more egalitarian fashion than public vacancy creation. Finally, we show that an education reform, which makes primary education compulsory, slightly increases overall unemployment. While private-formal job creation reacts only marginally (or negatively) to the higher average educational attainment of the labour force, the compositional effect on unemployment dominates: the educated workers who tend to have higher unemployment rates are more numerous.

Our paper ties into three different strands of the literature. First of all, it relates to a very small literature which studies educated unemployment in a developing context. For example, Fan and Stark (2007) and Stark and Fan (2011) explain educated unemployment within a theoretical model as a result of international migration prospects and rigid wages. In this paper, we privilege

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[7]See http://www.un.org/millenniumgoals/

as main explanatory factor for educated unemployment the workings of Sub-Saharan labour markets and the role of the public sector in particular.[8] To study these West African labour markets, we build a search matching model of equilibrium unemployment. This structural set-up is key to evaluating the effect of public policies.

Our paper builds on a second strand of the literature of search and matching models which study public sector employment or self-employment in a search and matching model of equilibrium unemployment. Search and matching models with a public sector include Burdett (2012), Bradley et al. (2017), Gomes (2015), Albrecht et al. (2015), and Langot and Yassin (2016). Albrecht et al. (2011), Kerr (2012) and Narita (2017) model self-employment in a search and matching model in a developing country context.

Among these papers, Albrecht et al. (2015) is closest to ours both in terms of the model and the emphasis on labour market in developing economies, though they calibrate it for a Latin American country (i.e. Colombia). We extend their model by adding another sector in the labour market: self-employment. Sub-Saharan African economies are characterised by large shares of the workforce in self-employment. Moreover, becoming self-employment could be a strategy for unemployed workers while waiting for a better offer in the public or private-formal sector. Studying self-employment is thus key to understanding educated unemployment in particular and labour markets in Sub-Saharan Africa in general.

Finally, our paper also relates to the literature on heterogeneous workers, who differ by skill level or education, in a search and matching framework. These papers include Gautier (2002), who studies the positive and negative externalities of skilled workers on the labour market outcome of unskilled workers, Charlot and Decreuse (2010), who analyse education choices in a two sector/two education level matching model, and Flinn and Mullins (2015), who model and estimate an equilibrium search model with a binary education decision. The first paper models search in a semi-segmented fashion (i.e. high-skilled workers can search for simple jobs, but not vice versa), while the later two papers assume that the search market is completely segmented by education. In our set-up, workers (and firms) cannot direct their search. In equilibrium, heterogeneous workers are employed in all three sector, though with different shares (as is observed in the data). In our model, the public and private-formal sector directly compete for the same workers by posting vacancies. An increase in public sector vacancies impacts job filling-rates in the private-formal sector, and vice versa. This allows us to study how labour market policies targeted towards one sector - such as the public vacancy creation policy- have spillover effects unto other sectors and reshuffle workers across sectors.

The remaining part of this paper is structured as follows. Section 2 presents the data and some stylised facts about (educated) unemployment and labour markets in urban West Africa. Section 3 develops a search- and matching framework with different sectors and heterogeneous

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[8]According to the Worldbank Indicators, in Francophone West Africa emigration rates of tertiary educated in 2012 are below the average rate of 18.9% for low-income economies. Moreover, a considerable share of 'international' migration in our sample occurs within the region of Francophone West African countries (see Vreyer et al. (2009)).

individuals who differ in their education level. In Section 4 we present the estimation strategy and discuss identification. In Section 5 we estimate this model to recover the underlying structural parameters, which we then use to decompose educated unemployment (Section 6) and to evaluate alternative education and labour market policies (Section 7). Section 8 concludes.

2 Stylized Facts

In this section, we highlight some stylized facts of labour markets in Francophone West-Africa. We start by presenting the data used for this study. Then, we discuss the structure of the studied labour markets with respect to three dimensions: the heterogeneity across employment sectors, the heterogeneity of unemployment probability across education groups, and the transition between employment status.

2.1 Data

The data set used in this paper is drawn from the first phase of the 1-2-3-Survey (see Brilleau et al. (2005)) conducted in 2001 and 2002 in the economic capitals of the members of the West African Economic and Monetary Union (UEMOA). These include Benin (Lomé), Burkina Faso (Ouagadougou), Côte d'Ivoire (Abidjan), Mali (Bamako), Niger (Niamey), Senegal (Dakar) and Togo (Cotonou). The 1-2-3-Survey is a household survey with approximately 7,500 to 14,000 individual observations per country. It contains information on socio-demographic characteristics, current labour market status, part of the employment history (max. last two spells), actual income, income aspiration, reservation wage and employment perspectives. Some sample statistics of individuals aged 10 and above are summarised in Table 1.

	Benin	Burkina	C-Ivoire	Mali	Niger	Senegal	Togo	Total
Summary statistics								
Observations	8,967	10,295	8,682	9,061	10,141	14,871	7,548	69,565
Age	29.6	28.3	27.9	29.1	28.4	29.4	28.6	28.8
Women (%)	51.9%	49.9%	50.7%	50.7%	51.6%	52.4%	52.4%	51.4%
Born in capital (%)	50.6%	44.8%	37.5%	50.4%	50.4%	63.6%	40.9%	49.8%
Labour market status and earnings								
Students (% of sample)	32.6%	40.2%	31.4%	46.7%	38.7%	32.8%	33.2%	36.0%
Employed students (% of students)	4.2%	5.7%	5.6%	12.7%	9.4%	6.2%	18.1%	8.6%
Labour force (% of sample)	63.1%	62.2%	67.1%	55.5%	54.6%	53.9%	69.5%	60.0%
Unemployment (% of labour force)	6.0%	20.1%	15.5%	10.7%	22.1%	20.0%	9.4%	15.3%
Monthly earnings (CFA)	44,700	40,300	70,000	62,600	41,000	55,300	27,300	48,400
Educational attainment (excl. current students)								
No schooling (%)	27.4%	45.2%	37.4%	55.5%	47.8%	38.5%	22.5%	39.7%
Education (years)/schooling	8.76	8.46	9.00	9.92	8.63	8.23	8.27	8.66

Table 1: Sample characteristics (age 10 and above)

The population in the seven economic capitals is relatively similar in terms of age and gender composition. Larger differences emerge in terms of the share of natives (from 38% in Abidjan to 64% in Dakar), school attendance (high schooling rates of more than 70% in Cotonou and Lomé), and the share of the population in the labour force (from 54% in Dakar and Niamey to 70% in

Cotonou). Unemployment rates also vary from 6% in Lomé to more than 20% in Ouagadougou, Niamey and Dakar.

Around 40% of the individuals in urban West Africa have never gone to school. Those who have ever attended school, have been in education for around 8 to 9 years, which corresponds to having something between primary (6 years) and lower secondary education (10 years). Two factors contribute to the relatively low educational attainment. First, a large share of the population never attend school because of financial reasons (around 30%, not shown). Secondly, drop out rates from school are relatively high. Individuals who drop out do so because they have a preference for a professional pathway (around 20%, not shown) or because of academic failure (another 20%, not shown).

2.2 The Heterogeneity across Employment Sectors

Labour markets in developing countries are known to be very heterogeneous. A common distinction is usually made between the public, formal and the informal sector. The informal sector spans the economic activity which is not monitored by the government and does not pay taxes (and social security contributions). Self-employment in one-person firm and non-salaried work makes up a significant share of the informal sector (around 85% in our data). In order to avoid confusion with the term 'informal sector' used in the context of Latin American countries[9], we apply the term self-employment instead.

A first dimension of heterogeneity between sector is the education level of the employees within each sector. Figure 2 shows the activity status and the sectoral composition of the employed labour force of men by education level.
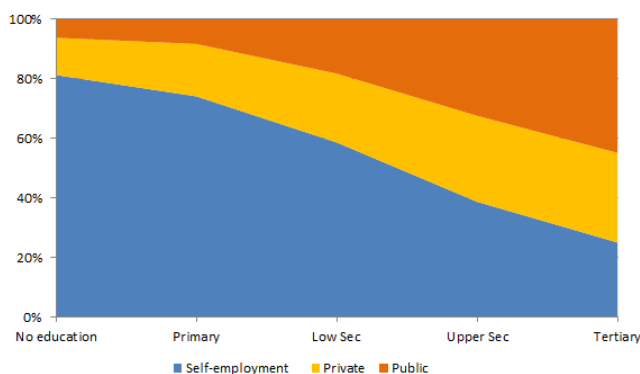
Figure 2: Activity & employment status of men (25 to 64 year-olds)

As the education level increases, the share of employment in the public sector increases whereas the share in self-employment decreases. However, labour markets are not (strictly) segmented along education. Around 6% of the uneducated labour force works in the public

[9]Most papers using data on Latin American countries define the informal sector as wage earners who do not contribute to social security and self-employed workers (see, for example, Albrecht et al. (2011) and Meghir et al. (2015).

sector (compared to 40% among those with tertiary education), and close to 20% of the working labour force with tertiary education is self-employed (80% among the uneducated). The share of private-formal employment remains relatively stable across education levels at 15% to 20%.

A second dimension of heterogeneity between the sectors is the wage paid to the employees. Figure 3 shows the distribution function of the log-wage by education level and by sector.

The public sector pays a wage premium for all education levels, except at tertiary education. Generally, incomes in the public sector are highest, followed by those in the private-formal sector, and then self-employment. Incomes in the private-formal sector are on average approximately 20% lower than in the public sector for individuals with primary or secondary education. Self-employed workers earn 15% to 40% less than those in the public sector, the difference again being largest for those with primary and (lower) secondary education. Moreover, income dispersion is lowest in the public sector and highest in self-employment.

2.3 The Heterogeneity of Unemployment Probability across Education Groups

Table 2 presents the general patterns of unemployment in our sample.

	None	Primary	Lower secondary	Higher secondary	Tertiary
Unemployment rate	13.5%	16.5%	18.7%	14.6%	11.7%
Unemployment rate (25 to 64 years)	12.3%	14.3%	16.2%	13.7%	11.3%
Unemployed since ... years	4.35	3.95	4.09	3.67	2.45
Labour market entrant (% of unemployed)	52.3%	56.2%	58.2%	59.5%	68.7%

Notes: Labour market entrants are individuals who are looking for their first job.

Table 2: Unemployment characteristics by education level

The unemployment rate is hump-shaped, both when considering the full labour force aged 10 and older, as well as when considering only those aged 25 to 64. The slightly lower unemployment rate among the second group indicates that unemployment is more prevalent in the early and very late years of labour market participation. This fact is also reflected in the high share of labour market entrants among the unemployed. More than 50% of all unemployed have not previously been employed, indicating that the transition from out of the labour force/school to working is highly frictional. The duration of the current unemployment spell decreases with the education level.

We assess the robustness of those descriptive results by controlling on potential confounders. Namely, we include in a reduced form regression (of the employment outcome) sets of controls about individual characteristics (education and experience), and household-specific controls (household income excluding the individual of interest, share of unemployed/non-working in household, size of household, father's education). Furthermore, we analyse the effect of education on unemployment using different sub-samples based on age at survey, and on the father's education. The results are presented in Table 3.

The first column shows that, compared to the reference group (no education), the probability
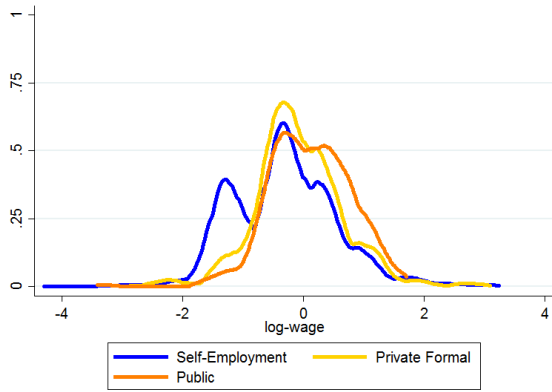
(a) No Education
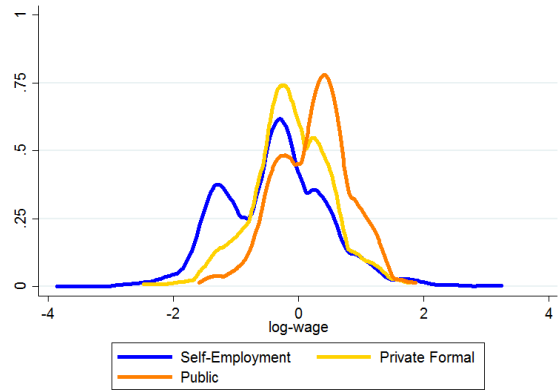
(b) Primary

(c) Lower Secondary

(d) Upper Secondary

(e) Tertiary

Note: Estimated log-wage density function subtracting the average log-wage level for each country of education.

Figure 3: Density Function of the Log-wage by sector and by Education Level

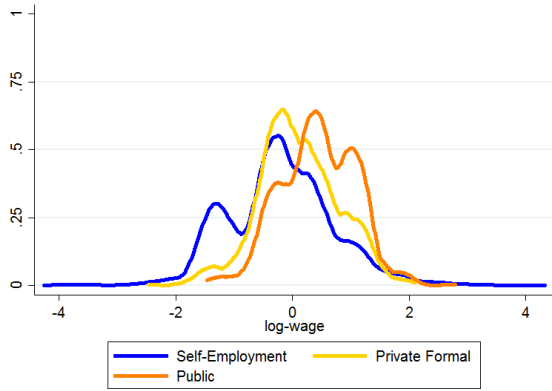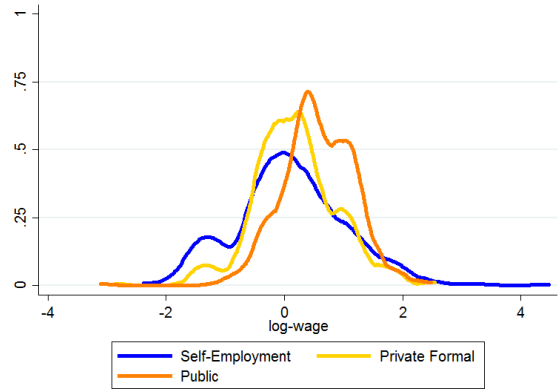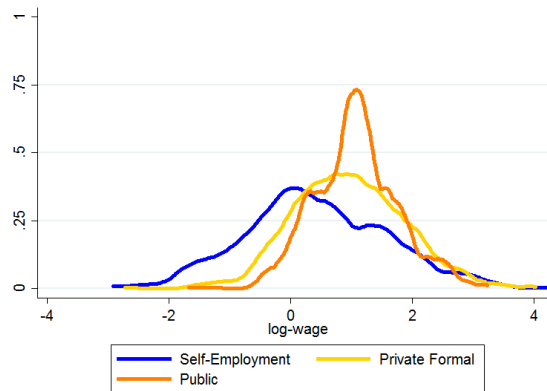|	No HH Controls	HH Controls				
	All	All	Age 25-34	Age 35 - 64	Father No educ.	Father some educ
Primary	0.016*	0.012	-0.043**	0.049***	0.012	-0.001
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
Lower secondary	0.034***	0.026***	-0.016	0.052***	0.032***	-0.018
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)
Upper Secondary	0.012	0.002	-0.074**	0.041**	0.003	-0.016
	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)	(0.03)
Tertiary	-0.031**	-0.041***	-0.121***	0.008	-0.049***	-0.036
	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.02)
Observations	15,665	15,665	6,932	8,733	11,187	2789

Linear Probability model of Unemployment Probability at the time of the survey.

All models control for potential experience, migration status and country fixed-effects.

All models, except the first, control for family characteristics.

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

Table 3: The Effect of Education on the Unemployment Probability (Linear-Probability Model)

to be unemployed increases first with the level of education, being the highest for those with a secondary education (3.4 percentage point increase, that is a 41% increase from the average). Then, the unemployment probability drops to fall below the reference level for those with the tertiary education. Including the household characteristics does not change the pattern significantly. Irrespective of the sub-group considered, the unemployment rate seems to be at least as high in secondary education, as it is in the reference group.

2.4 Labour market entry and transition

This subsection analyses labour market entry and transition of men aged 25 to 64 years. Table 4 presents 3-year transition rates between different employment status by education level. We distinguish unemployed (and inactive) individuals, those who are self-employed (incl. family workers and salaried employees in the informal sector), salaried employees in the private-formal sector and employees in the public sector.

Overall, Table 4 shows a high persistence in labour market states over a 3-year period (reflected by the diagonal elements in each panel). One out of three men who were unemployed (or inactive) 3 years ago are still unemployed in the current period. For those who were employed in the public or private-formal sector around between 80% and 90% are still employed in the same sector. For those in self-employment, on average less than 5% had left self-employment in this period.

Beyond these general patterns, observed labour market transitions differ substantially by education level. The probability of staying employed in the public sector increases from 73% in the case of no education, to 98% with a tertiary education. Conversely, the stayer-probability in the self-employment sector decreases from 98% to 80%. Besides, the probability that an unemployed (or inactive) individual remains in unemployment slightly increases with education. The probability of moving from employment to unemployment depends both on the sector of employment and on the education level of the individual.

Past Labour Market Status	Current Labour Market Status			
	Unemployed /Inactive	Self-employed	Private-formal	Public
No education				
Unemployed/Inactive	30.0%	56.5%	11.3%	2.2%
Self-employed	1.2%	98.3%	0.4%	0.1%
Private	6.0%	6.2%	87.6%	0.3%
Public	8.4%	16.9%	1.5%	73.2%
Total	6.8%	78.5%	9.9%	4.8%
Primary education				
Unemployed/Inactive	29.9%	52.6%	14.3%	3.2%
Self-employed	1.9%	96.7%	1.0%	0.5%
Private	7.1%	7.5%	84.6%	0.7%
Public	7.8%	10.3%	3.8%	78.1%
Total	9.1%	67.1%	16.1%	7.7%
Lower secondary education				
Unemployed/Inactive	32.2%	42.1%	17.7%	8.0%
Self-employed	3.0%	93.7%	2.6%	0.7%
Private	9.2%	7.1%	82.7%	1.0%
Public	3.0%	6.4%	0.8%	89.8%
Total	11.7%	51.3%	20.6%	16.4%
Upper secondary education				
Unemployed/Inactive	33.2%	25.5%	23.2%	18.1%
Self-employed	3.9%	89.6%	4.1%	2.4%
Private	4.7%	4.5%	89.3%	1.5%
Public	0.6%	2.1%	0.6%	96.6%
Total	11.6%	32.3%	26.3%	29.7%
Tertiary education				
Unemployed/Inactive	36.4%	20.2%	24.5%	19.0%
Self-employed	3.1%	80.6%	4.3%	12.0%
Private	4.0%	6.6%	88.1%	1.3%
Public	0.5%	0.4%	1.1%	98.1%
Total	11.9%	22.7%	27.2%	38.3%

Table 4: Observed 3-year labour market transition rates of men (25 to 64 year-olds)

Moreover, the education level is crucial in determining in which sector a labour market entrant or an unemployed individual finds employment (first row in each panel of Table 4). An unemployed/inactive individual without schooling finds employment in the private-formal or public sector with a probability of 12.5%. This probability increases to 45% for someone with tertiary education. The converse is true for transition from unemployment/inactivity to self-employment. It monotonically decreases with education: from more than 56% for individuals without education to close to 20% for those with tertiary education. This evidence suggests that individuals with higher education could have an interest in searching longer for a job in the private-formal or public sector before becoming self-employed (i.e. downgrading).

This interpretation would also be in line with the finding that once an individual is employed in a specific sector, relatively little sectoral transition occurs and an individual's education affects these transition probabilities only marginally. Moreover, observed separation rates (second column in Table 4) vary greatly across sectors. The risk of moving from self-employment into unemployment is between 4% and 9% over a 3-year period, while transition from the public sector to unemployment is lower than 1% for those with tertiary education and 8.4% for those without any education.

3 An equilibrium search model with a public sector and self-employment

In this section we develop a simple general equilibrium search and matching model in the spirit of Pissarides-Mortensen-Diamond (see Pissarides (2000)). Our model captures key features of West-African (and Sub-Saharan) labour markets and allows us to evaluate different labour market policies which have been implemented (or suggested) to alleviate (educated) unemployment. One main ingredient of our model is the specificity of the labour market side which consists of a public sector, a private-formal sector and self-employment. Each sector is characterised by a different production function, wage rule and frictions. Workers are heterogeneous and differ in their education level. The rich labour market structure on the one side and the heterogeneity of workers on the other side result in (imperfect) sorting of workers across sectors and education-specific unemployment rates.

Workers differ in their education level y.[10] The overall education distribution of workers in the economy is given by $F(y)$. At any time, a worker is either (i) unemployed, (ii) employed in the public sector, (iii) employed in the private-formal sector or (iv) self-employed. Unemployed workers randomly search for jobs without targeting any sector in particular.[11] Contact rates thus do not depend on the worker's education level. Each contact produces a match-specific productivity x. The

---

[10]A straightforward extension of the model would endogenise the schooling decision of workers. In this case, the search model presented below would reflect the second stage (i.e. labour market phase). The first stage (i.e. education phase) in which individuals make an education choice is presented in Appendix B. The notation of worker heterogeneity y would not only reflect different education levels, but also differences in family wealth and/or ability.

[11]The assumption of random search produces imperfect sorting of heterogeneous workers across sectors as is observed in the data.

distribution of the match $F_{X,j,y}$ depends on the sector j and the worker's education level y. Self-employed workers continue to randomly search for jobs in the public and private-formal sector (but not in self-employment), albeit at a reduced intensity ψ. Workers employed in the public or private-formal sector do not search on the job.[12] Jobs in all sectors get destroyed exogenously at rate $\delta_j(y)$.

The public sector and private firms post vacancies at rates v_g and v_p, respectively. Let $\phi = v_p/(v_p + v_g)$ be the proportion of vacancies posted by private firms. Matching in the public and private-formal sector is governed by a matching function (with usual properties) which depends on total public and private vacancies on the one hand, and the total number of unemployed and self-employed workers (and their search efficiency) on the other hand. A key determinant of contacts is the labour market tightness $\kappa = \frac{u+\psi n_s}{v_p+v_g}$, where u and n_s are the overall share of unemployed and self-employed workers, respectively. Self-employment opportunities arrive at Poisson rate λ_s. We think of these self-employment opportunities as business ideas with which a worker comes up. They arrive randomly and are independent of the state of the labour market (i.e. labour market tightness).[13] Self-employment can thus serve as a buffer between the public/private-formal sector and unemployment. Modelling self-employment is important because policies targeted at the public or private-formal sector not only have repercussions on unemployment, but also on self-employment. Moreover, encouraging self-employment is one important pillar of labour market public policies in Francophone West Africa.

3.1 The value of unemployment and employment in each sector

Workers differ by education y and maximise their expected life-time income discounted at rate r. An unemployed worker receives a flow income of $b(y)$. For an unemployed worker, offers from the private-formal and the public sector arrive at Poisson rates $\lambda_{p,u}$ and $\lambda_{g,u}$, respectively (and are determined in equilibrium), and from the self-employment sector at exogenous rate λ_s. These offers are drawn from sector-specific productivity distributions $F_{X,j,s}$. The present value of unemployment V_U can thus be written as:

$$
\begin{aligned}
rV_U(y) \quad = b(y) \quad &+\lambda_{p,u}\mathbb{E}_{F_{X,p,y}}\max\{V_p(x,y) - V_U(y), 0\} \\
&+\lambda_{g,u}\mathbb{E}_{F_{X,g,y}}\max\{V_g(x,y) - V_U(y), 0\} \\
&+\lambda_s\mathbb{E}_{F_{X,s,y}}\max\{V_s(x,y) - V_U(y), 0\}
\end{aligned}
\tag{1}
$$

where $V_j(x,y)$ is the value of employment in sector j given a match-specific productivity x.

The value of employment in the private-formal or public sector depends on whether the worker was unemployed or self-employed in the previous spell. Given that firms and workers bargain

---

[12]Average duration of employment in the public sector is above 17 years and it exceeds 13 years in the private-formal sector in all seven countries.

[13]In this setting, self-employment opportunities are not always available. λ_s can be interpreted as an (inverse) measure of barriers of entry to (profitable) self-employment. In the limiting case when λ_s tends to infinity, self-employment opportunities become a fall-back option which is always available. According to the survey, the two main reasons of unemployed workers in West Africa for not becoming self-employed are (i) the difficulty of becoming self-employed (54%) and (ii) low incomes in self-employment (20%).

over wages w, a previously self-employed individual may command a different wage from an unemployed worker because his outside option in the bargaining process was different. However, jobs get destroyed at rate $\delta_j(y)$, independently of the worker's previous employment status. The first two equations show the present value of employment in the private-formal and public sector of a worker transiting out of unemployment, while the last two questions show the respective present values of employment in each sector given a previous productivity in self-employment of x_s :

$$rV_p(x,y) = w_p(x,y) + \delta_p(y)\left(V_U(y) - V_p(x,y)\right) \tag{2}$$

$$rV_g(x,y) = w_g(x,y) + \delta_g(y)\left(V_U(y) - V_g(x,y)\right) \tag{3}$$

$$rV_{p,s}(x,x_s,y) = w_{p,s}(x,x_s,y) + \delta_p(y)\left(V_U(y) - V_{p,s}(x,x_s,y)\right) \tag{4}$$

$$rV_{g,s}(x,x_s,y) = w_{g,s}(x,x_s,y) + \delta_g(y)\left(V_U(y) - V_{g,s}(x,x_s,y)\right) \tag{5}$$

A self-employed worker receives as income the match-specific productivity x_s at any instant. Offers from the public and the private sectors arrive at Poisson rates $\lambda_{p,s}$ and $\lambda_{g,s}$, respectively. Self-employed workers of education level y draw from the same productivity distributions as unemployed workers.[14] Self-employment gets exogenously destroyed at rate $\delta_s(y)$. The present value for self-employment can thus be written as:

$$
\begin{aligned}
rV_s(x_s,y) \quad = x_s \quad &+\delta_s(y)\left(V_U(y) - V_s(x_s,y)\right) \\
&+\lambda_{p,s}\mathbb{E}_{F_{X,p,y}}\max\{V_{p,s}(x,x_s,y) - V_s(x_s,y),0\} \\
&+\lambda_{g,s}\mathbb{E}_{F_{X,g,y}}\max\{V_{g,s}(x,x_s,y) - V_s(x_s,y),0\}
\end{aligned} \tag{6}
$$

3.2 The value of posting a private-formal vacancy and a filled job

Private-formal firms are homogeneous. They post a vacancy at a flow cost of c. Contact with a searching worker (unemployed or self-employed) occurs at rate $q(\kappa)$, which will be determined in equilibrium. Firms, like workers, cannot direct their search and hence, they must take the expectation over the joint distribution of match-specific productivity shocks and education both among unemployed and self-employed workers. The flow value of a filled job is the surplus a private-formal firm makes, that is, the difference between the match-specific productivity shocks and the wage the firm has to pay.

Let $J_u(x,y)$ be the present value associated with a job filled by a worker previously unemployed of type (y) whose match-productivity is x. Let $J_s(x,x_s,y)$ be the present value associated with a job filled by a worker previously self-employed of type (y) whose match-productivity is x, and whose productivity in self-employment was x_s. Denote by V the value of posting a private-sector vacancy. The value for a private-formal firm to post a vacancy or to have a filled job is:

---

[14]Given that our data does not contain any information about wages in the previous spell, we cannot identify productivity distributions conditional on the previous employment status of the worker.

$$rV = -c + q(\kappa)\frac{u}{u + \psi n_s}\mathbb{E}_{F_{X,Y,p}}\max\{J_u(x,y) - V, 0\}$$

$$+ q(\kappa)\frac{\psi n_s}{u + \psi n_s}\mathbb{E}_{F_{X,X_s,Y,p}}\max\{J_s(x,x_s,y) - V, 0\} \tag{7}$$

$$rJ_u(x,y) = x - w_p(x,y) - \delta_p(y)J_u(x,y) \tag{8}$$

$$rJ_s(x,x_s,y) = x - w_{p,s}(x,x_s,y) - \delta_p(y)J_s(x,x_s,y) \tag{9}$$

For the value of posting a vacancy (equation (7)), the first expectation is taken over (x, y), while the second expectation is taken over (x, x_s, y), where x_s is the productivity of those who accepted a self-employment job. Note that we assume that once a job is destroyed, the firm does not open a new vacancy.

3.3 The public sector

We model the public sector in the same fashion as Albrecht et al. (2015). Firstly, the public sector posts a fixed amount of vacancies v_g. The public sector meets (self-employed or unemployed) searchers at the same rate as private-formal firms, i.e. $q(\kappa)$. Like private-formal firms and workers, the public sector cannot direct its search and it does not hire preferentially. Secondly, wages in the public sector are determined by an exogenous scheme $w_g(x,y)$, which is indifferent to the current labour market state of the worker (self-employed or unemployed):

$$w_g(x,y) = \pi(y) + \gamma x + (1 - \gamma)rV_U(y) \tag{10}$$

The public sector's wage scheme is comparable to the wage rule for the private-formal sector (see below equations (11) and (12)), but it is different in two important aspects. First, the public sector pays a premium of $\pi(y)$ (which can be 0). Secondly, the public sector may apply a different weight to productivity, i.e. γ, than what results from the bargaining process of workers and the private-formal sector.

Moreover, we assume that the public sector only hires workers if $x \geq w_g(x,y)$. This condition in combination with non-negative public wage premia $\pi(y)$ is equivalent to saying that public sector jobs are rationed. The larger $\pi(y)$, the larger the match-specific productivity x required by the public sector to hire the worker.[15]

3.4 Wages and reservation productivities

Wages in the private-formal sector are determined by Nash bargaining. The worker's bargaining power is given by β. The worker bargains with the present value of unemployment or self-employment as an outside option, while the firm's surplus is the value of a filled job.

---

[15]The worker would accept the public job for lower x. Hence, the larger $\pi(y)$, the larger the rationing and the larger the discrepancy between the binding large productivity requirement of the public sector and the worker's low reservation productivity.

The following equations characterize the private-formal wage rules and the reservation productivities in each sector. We define the reservation productivity in sector $R_j(y)$ as the productivity for which the worker and/or the employer (firm or public sector) are indifferent between consummating the match and not consummating. For the details of the derivation, see Appendix A.

$$w_p(x,y) = \beta x + (1-\beta)R_p(y) \tag{11}$$

$$w_{p,s}(x,x_s,y) = \beta x + (1-\beta)R_{p,s}(x_s,y) \tag{12}$$

$$R_p(y) = b(y) + \frac{\lambda_{p,u}\beta}{r+\delta_p(y)}\int_{R_p(y)}[x-R_p(y)]\ dF_{X,p}(x|y)$$
$$+\frac{\lambda_{g,u}}{r+\delta_g(y)}\int_{R_g(y)}[w_g(x,y)-R_p(y)]\ dF_{X,g}(x|y)$$
$$+\frac{\lambda_s}{r+\delta_p(y)}\int_{R_s(y)}[R_{p,s}(x,y)-R_p(y)]\ dF_{X,s}(x|y) \tag{13}$$

$$R_g(y) = \frac{\pi(y)}{1-\gamma} + R_p(y) \tag{14}$$

$$R_s(y) = R_p(y) - \frac{\lambda_{p,s}\beta}{r+\delta_p(y)}\int_{R_p(y)}[x-R_p(y)]\ dF_{X,p}(x|y)$$
$$-\frac{\lambda_{g,s}}{r+\delta_g(y)}\int_{R_{g,s}(R_s(y),y)}[w_g(x,y)-R_p(y)]\ dF_{X,g}(x|y) \tag{15}$$

$$R_{p,s}(x_s,y) = R_p(y) + \frac{r+\delta_p(y)}{r+\delta_s(y)}(x_s - R_p(y))$$
$$+\frac{\lambda_{p,s}(y)\beta}{r+\delta_s(y)}\int_{R_{p,s}(x_s,y)}[x-R_{p,s}(x_s,y)]\ dF_{X,p}(x|y)$$
$$+\frac{r+\delta_p(y)}{r+\delta_s(y)}\frac{\lambda_{g,s}(y)}{r+\delta_g(y)}\int_{R_{g,s}(x_s,y)}[w_g(x,y)-R_p(y)]\ dF_{X,g}(x|y)$$
$$-\frac{\lambda_{g,s}(y)\left[1-F_{X,g}(R_{g,s}(x_s,y)|y)\right]}{r+\delta_s(y)}[R_{p,s}(x_s,y)-R_p(y)] \tag{16}$$

$$\tilde{R}_{g,s}(x_s,y) = R_p(y) + \frac{1}{\gamma}\left[\frac{r+\delta_g(y)}{r+\delta_p(y)}[R_{p,s}(x_s,y)-R_p(y)]-\pi(y)\right] \tag{17}$$

$$R_{g,s}(x_s,y) = max\left(\tilde{R}_{g,s}(x_s,y), R_g(y)\right) \tag{18}$$

Equations 11 and 12 give the wage rule in the private-formal sector, conditional on the worker's past labour market status. The first two components of the wage rule of a worker in a private-formal firm who was previously self-employed is identical to the wage rule of one who was unemployed. However, the previously self-employed worker additionally receives a fraction of the value of the surplus from self-employment, compared to unemployment (equation (12)). At the reservation productivity in self-employment $R_s(y)$, the surplus from self-employment is 0, and hence, the wage rule is the same as of an unemployed worker.

The reservation productivity in the private-formal sector and self-employment is such that the worker is indifferent between accepting a job at productivity x and remaining in unemployment. The reservation productivity of transiting from self-employment to private-formal employment is when the worker is indifferent between accepting the new private-formal job and remaining in

self-employment. Note that the reservation wage for self-employment (equation (15)) is lower than the reservation wage for employment in the private sector (equation (16)). That is because the self-employed present value accounts for the possible transition in the future.

Equation (14) characterizes the reservation productivity in the public sector. Finally, the reservation productivity in the public sector coming from self-employment is the maximum of the public sector's reservation productivity (equation (14)) and the worker's reservation productivity (equation (17)).

3.5 Matching function

Let m be the measure of contacts in the economy, n_s be the proportion of self-employed. Denote by v the total number of vacancies posted by the public and the private firms. The matching technology is characterized by the Cobb-Douglas function

$$m = (u + \psi n_s)^\eta v^{1-\eta}$$

where $0 < \psi \leq 1$ reflects the lower search efficiency of individuals who are currently self-employed relative to the unemployed. The rate of contacts per vacancy is

$$q(\kappa) = \kappa^\eta$$

where $\kappa = (u + \psi n_s)/v$, and κ is a measure of the market tightness. The proportion of self-employed who are searching is given by $\psi n_s/(u + \psi n_s)$. Contacts with public and private occur randomly, and contact rates do note vary with y. The contact rate of a self-employed is then given by:

$$\lambda_{p,s} = \phi \frac{\psi n_s}{u + \psi n_s} \frac{m}{n_s} = \phi \psi \kappa^{\eta-1} \tag{19}$$

$$\lambda_{g,s} = (1-\phi) \frac{\psi n_s}{u + \psi n_s} \frac{m}{n_s} = (1-\phi) \psi \kappa^{\eta-1} \tag{20}$$

The contact rate of an unemployed is given by:

$$\lambda_{p,u} = \phi \kappa^{\eta-1} \tag{21}$$

$$\lambda_{g,u} = (1-\phi) \kappa^{\eta-1} \tag{22}$$

3.6 Free-entry and steady state conditions

Using the fact that:

$$J_u(x,y) = \frac{1-\beta}{r + \delta_p(y)} (x - R_p(y)) \tag{23}$$

and

$$J_s(x, x_s, y) = \frac{1-\beta}{r + \delta_p(y)} (x - R_{p,s}(x_s, y)) \tag{24}$$

and the free-entry condition $V = 0$ in equation (7), it follows that:

$$
\begin{aligned}
0 \;=\;& -c + q(k)\frac{u}{u+\psi s}\int\int_{R_p(y)}\frac{1-\beta}{r+\delta_p(y)}(x-R_p(y))dF_{X,p}(x|y)dF_Y(y|U) \qquad (25)\\
&+q(k)\frac{\psi s}{u+\psi s}\int\int_{R_s(y)}\int_{R_{p,s}(x_s,y)}\frac{1-\beta}{r+\delta_p(y)}(x-R_{ps}(y))dF_{X,p}(x|y)dF_{X,s}(x_s|y)dF_Y(y|S)
\end{aligned}
$$

Note that $F_{X,p}(x|x_s,y) = F_{X,p}(x|y)$, and $F_{X,p}(x|y,S) = F_{X,p}(x|y)$. The two unknown are $dF_Y(y|U)$ and $dF_Y(y|S)$, where the latter is the distribution y among self-employed. To characterize both distributions, it suffices to use the following conditions:

$$
dF_Y(y|U) = \frac{u(y)dF_Y(y)}{u},
$$

and

$$
dF_Y(y|S) = \frac{n_s(y)dF_Y(y)}{s},
$$

and the steady-state conditions given by:

$$
\begin{aligned}
\delta_p(y)n_p(y) \;=\;& \lambda_{p,u}\left[1-F_{X,p}(R_p(y)|y)\right]u(y)\\
&+\lambda_{p,s}\int_{R_s(y)}\left[1-F_{X,p}(R_{p,s}(x_s,y)|y)\right]dF_{X,s}(x_s|y)n_s(y) \qquad (26)\\
\delta_g(y)n_g(y) \;=\;& \lambda_{g,u}\left[1-F_{X,g}(R_g(y)|y)\right]u(y)\\
&+\lambda_{g,s}\int_{R_s(y)}\left[1-F_{X,g}(R_{p,s}(x_s,y)|y)\right]dF_{X,s}(x_s|y)n_s(y) \qquad (27)\\
\delta_s(y)n_s(y) \;=\;& \lambda_s\left[1-F_{X,s}(R_s(y)|y)\right]u(y)\\
&-\lambda_{p,s}\int_{R_s(y)}\left[1-F_{X,p}(R_{p,s}(x_s,y)|y)\right]dF_{X,s}(x_s|y)n_s(y)\\
&-\lambda_{g,s}\int_{R_s(y)}\left[1-F_{X,g}(R_{g,s}(x_s,y)|y)\right]dF_{X,s}(x_s|y)n_s(y) \qquad (28)
\end{aligned}
$$

and

$$
n_p(y) + n_g(y) + n_s(y) + u(y) = 1. \qquad (29)
$$

Finally, given that v_g is exogenously determined equation (30) closes the model:

$$
\phi = \left(\frac{u+\psi n_s}{\kappa} - v_g\right)/\frac{u+\psi n_s}{\kappa} \qquad (30)
$$

4   Identification and estimation

We estimate the model from Section 3 on spell data from the 1-2-3-Survey on seven Francophone West African capitals. We consider men who were between 18 and 64 years old and who worked at least 30 hours or who were unemployed. y corresponds to the five education levels used in the survey: no education, primary, lower secondary, upper secondary and tertiary education. The education distribution $F(y) = P(y)$ is thus discrete and is taken from the data. In order to reduce the impact of measurement error, we trim the bottom 10% and top 5% of the income distribution

for each education level.

4.1 Identification

We estimate the model by simulated method of moments. To identify the structural parameters of our model, we target a set of moments. These moments include static and dynamic moments on wages (by education), unemployment rate (by education), the sectoral distribution (by education), the educational composition of sectors, employment duration in all sectors and 3-year transition rates (by education). Table 5 summarises the parameters to be estimated (column 1) and the corresponding moments used to identify them (column 2). Column 3 gives the number of moments. In total, there are 50 parameters (of which 4 are fixed ex-ante) and 178 moments.

Parameter	Moment	#
Productivity distribution by sector $F_{x,j,y}$		
Public sector: $\mu_g(y)$, $\sigma_g(y)$	Mean & std. dev. of public income by education	10
Formal-private sector: $\mu_p(y)$, $\sigma_p(y)$	Mean & std. dev. of formal income by education	10
Self-employment: $\mu_s(y)$, $\sigma_s(y)$	Mean & std. dev. of self-employment income by education	10
	Mean of public and formal income by education conditional on past self-employment	10
Reservation wages, public premium, search efficiency		
Reservation wage formal sector: $R_p(y)$	1st percentile of formal income by education	5
Public wage premium: $\pi(y)$	1st percentile of public income by education	5
Search efficiency in self-employment: ψ	1st percentile of self-employment income by education	5
Offer arrival and destruction rates		
Self-employment arrival rate: λ_s	Share of self-employment by education	5
Labour market tightness: κ	Share of public sector by education	5
Share of private vacancies: ϕ	Share of private sector by education	5
Destruction rates: $\delta_j(y)$	Mean employment duration by sector	3
	Unemployment rate by education	5
All above	3-year transition rates by education	80
	Educational composition of each sector	20
Calibrated parameters		
Bargaining power worker: $\beta = 0.5$		
Productivity weight in public: $\gamma = 0.5$		
Interest rate: $r = 0.10$		
Matching elasticity: $\eta = 0.5$		
Total moments		178

Table 5: Model parameters and corresponding moments

One key object of our model is the match-specific productivity distribution in each sector by education and the reservation productivity in the private-formal sector. The truncated productivity distribution relates directly to the observed wage distribution. In order to keep the estimation simple, we assume that the productivity distributions in all sector follow a log-normal distribution. This boils down to estimating the location $\mu_j(y)$ and scale parameter $\sigma_j(y)$ in each sector j for education level y. We use the mean and standard deviation of observed income by education in

each sector to identify these parameters.

The reservation productivity in the private-formal sector corresponds to the truncation point in the productivity distribution. Its empirical counterpart is the observed minimum income (see Flinn and Heckman (1982)). Instead of targeting the observed minimum income (which is most likely affected by measurement error), we use the lowest percentile of the private-formal income distribution to identify the reservation productivity.

In the same vein, we use the lowest percentile of the public and self-employment income distribution to identify the respective reservation productivities. The difference between the public reservation productivity and the private-formal one allows us to pin down the wage premium $\pi(y)$ in the public sector. The wedge between the self-employment and private-formal reservation productivity identifies the search efficiency in self-employment ψ.

Finally, we use the full set of 3-year transition rates between all sectors (by education), as well as sectoral distribution, unemployment rates, mean employment duration by sector and educational composition to pin down the labour market tightness κ, the share of private vacancies ϕ, the arrival rate of self-employment opportunities λ, as well as the sector-specific destruction rates (by education) $\delta_j(y)$.

Some parameters like the cost of vacancy posting c, the flow value of unemployment $b(y)$ and public vacancy posting v_g are not directly estimated. They can be backed out from the parameters estimated above and the equilibrium conditions.

There are a certain number of parameters we cannot identify from our data. We set them to conventional values such as the bargaining power of workers $\beta = 0.5$, the weight of productivity in the public sector $\gamma = 0.5$, the interest rate $r = 0.1$ and the matching elasticity $\eta = 0.5$.

4.2 Estimation and simulation protocol

The model is estimated by the Method of Simulated Moments (MSM). In a first step, we numerically solve the model given an initial set of parameters. To do so, we discretise the self-employment productivity distribution of x_s, and produce the reservation productivities (i.e. decision rules) in all sectors and the equilibrium conditions. In a second step, we use the reservation productivities and equilibrium conditions to simulate labour market outcomes (i.e. labour market status, wage and duration of the spell) for three spells of a set of individuals (10,000 individuals per education level[16]). Hereby, we produce a simulated data set. In a third step, we construct the moments from the simulated data set and compare them to their empirical counterparts. For the static moments we use the initial labour market status and wage. For the transition rates we compare the initial labour market status and 3 years later. Finally, using the Nelder-Mead algorithm these three steps are repeated with different sets of parameters until the quadratic loss function is minimised. The optimal parameter estimate $\hat{\theta}_{SMM}$ solves:

---

[16]For moments which are taken over all education levels, we apply re-weight the different education levels by $P(y)$ (see Table 6 in Appendix C.)

$$\hat{\theta}_{SMM} = \arg\min (\hat{\mu}(\theta) - \hat{m})' W (\hat{\mu}(\theta) - \hat{m}) \qquad (31)$$

where $\hat{m}$ is the vector of empirical moments (i.e. the sample estimate of the unknown population moments), $\hat{\mu}(\theta)$ are the simulated moments which are an estimate of the model's true unconditional moments $\mu(\theta)$, and W is the weighting matrix. We employ a diagonal weighting matrix where the inverse elements are the estimated variance[17] of the empirical moments. In order to achieve a very good fit on the unemployment rates, our main target, we increase the weight given to these moments by a factor 10.

5 Estimation results of the model

5.1 Estimation results

Tables 6 to 11 in Appendix C present the estimation results for Ouagadougou (Burkina Faso) and Dakar (Senegal). We focus on these two countries as representing two typical, but different cases in Francophone West Africa. At the time of the survey, in 2001, Senegal has the second highest GNI per person of the sampled countries (Côte d'Ivoire has the highest[18]), while the other five countries in the sample are less developed, with Burkina Faso being in the intermediate position in this second group. The full set of estimation results for all seven countries is available upon request.

5.1.1 Productivity distributions, reservation productivity and wages

The reservation productivity/wage $R_p(y)$ is convex in both countries, starting at around at 15,000 CFA/month in Burkina Faso and 20,000 CFA/month in Senegal and going up to more than 60,000 CFA for tertiary education. Interestingly, reservation wages for those without tertiary education are clearly below the official monthly minimum wage (28,800 CFA and 39,000 CFA in Burkina Faso and Senegal, respectively). The self-employment reservation productivity is only slightly lower than the one in the private-formal sector (reflecting the low search efficiency), though the gap increases with education. Moreover, the public wage premium (and hence, public sector rationing) is fairly small in Burkina Faso (except for primary education, where it is moderate), while it is quite large in Senegal.

In terms of the location parameter of the productivity distribution, we cannot establish a clear pattern other than that the mean productivity in self-employment is always lower than in the public or the private sector. In Burkina Faso, the public sector has the largest mean productivity for those with secondary education, while the formal sector dominates at the extremes of the education distribution. The converse holds for Senegal. Interestingly, the dispersion of the productivity increases in all sectors and both countries with education until higher secondary, only

---

[17]Some variances like the ones of the standard deviation of income and the first income percentile are bootstrapped.

[18]Côte d'Ivoire was undergoing a turbulant phase at the moment of the survey. It experienced a military coup in 1999, a constitutional reform in 2000 and two civil wars from 2002 to 2007 and from 2010 to 2011.
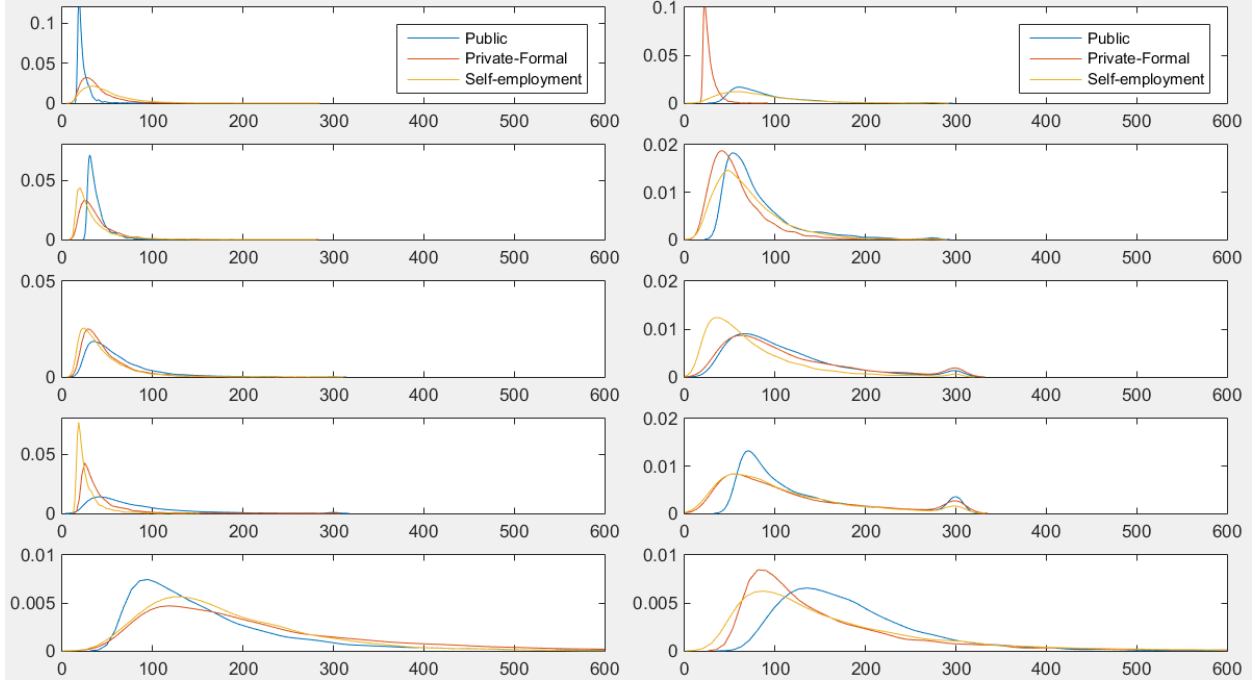
Figure 4: (Accepted) wage distribution by sector and education in Burkina Faso (left) and Senegal (right)

to decrease again for tertiary. The sectoral distribution of workers is not only determined by the highest mean productivity, but it also depends on rationing. For example, workers without any education have the highest mean productivity in the public or formal sector. Nonetheless, a large share of them works in self-employment. Due to the lower job arrival rate of public/formal offers than self-employment opportunities (see below) and the public sector rationing, a considerable share of uneducated workers ends up self-employed.

Figure 4 plots accepted wage distributions by sector and education.

In Senegal, incomes in the public sector first-order stochastically dominate incomes from private-formal and self-employment at all education levels. In Burkina Faso, this only holds for intermediate education levels (primary, lower and upper secondary). At the extremes of the education distribution, self-employment has a more disperse income distribution.

5.1.2 Arrival and destruction rates

The yearly offer arrival rate in the public/formal sector as well as in self-employment are very low. A worker in Burkina Faso receives on average 0.19 offers per year from the public/formal sector and 0.23 offers from self-employment. The numbers in Senegal are 0.14 and 0.17, respectively. A considerable share of workers do not get a single work offer within a year, leading to long unemployment spells. The offer rate in the public/formal sector translates into labour market tightness rates of 26.8 (Burkina Faso) and 47.7 (Senegal) searchers per vacancy. These rates seem extremely high. However, they reflect the order of magnitude of the rates reported by recent
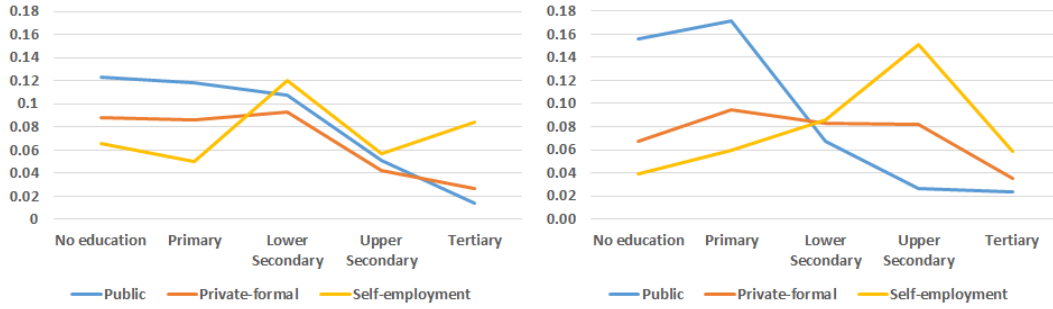
Figure 5: Estimated job destruction rates in Burkina Faso (left) and Senegal (right)

public recruitment schemes.[19]

A considerable share of vacancies are posted in the public sector. The share of private-formal vacancies amounts to 30% in Burkina Faso and 56% in Senegal. This remains much lower than the estimate of 92% reported for Colombia (see Albrecht et al. (2015)). In fact, public sector vacancy creation is not particularly high in West Africa (the respective rates of v_g are 0.59% and 0.23%, compared to 1.3% in Colombia), but private-formal vacancy creation is remarkably low.

In line with the job arrival rates, we also find relatively low destruction rates in all sectors and for all education levels (see Figure 5). However, an interesting pattern with respect to education emerges. Job destruction decreases with education in the public sector, and also in the formal sector (but to a lesser degree), yet it is hump-shaped and slightly increasing in self-employment. For example, a worker without education in Burkina Faso risks losing his public-sector job within a year with more than 12% chance, while the probability drops to 1% for someone with tertiary education. In self-employment, the destruction rate is hump-shaped in education, peaking at (lower or upper) secondary education.

5.1.3 Remaining parameters

Finally, the unemployment flow values are negative and decrease with education. This shape thus cannot explain the hump-shaped unemployment rates. This brings us to conclude that educated unemployment pattern is mostly driven by differences in sectoral productivity, public wage distortion and differential destruction rates across education levels and sectors. Those with intermediate education face relatively high destruction rates in all sectors, while those without education have a long expected duration in self-employment and those with tertiary education in the public sector.

5.2 Goodness of Fit

Tables 12 to 18 in Appendix D show how well the estimated model fits the data. Overall, the model does a good job in matching the data. Some moments such as the education-specific unemployment rates, sectoral employment shares by education and the educational composition of sectors are very precisely matched for both countries. The fit of the sectoral income distributions

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[19]In Senegal, more than 115,000 candidates applied for 5,500 jobs in 2013. In Burkina Faso in 2017, more than 900,000 applications were received for 11,000 public jobs. (All media sources in Appendix F.)
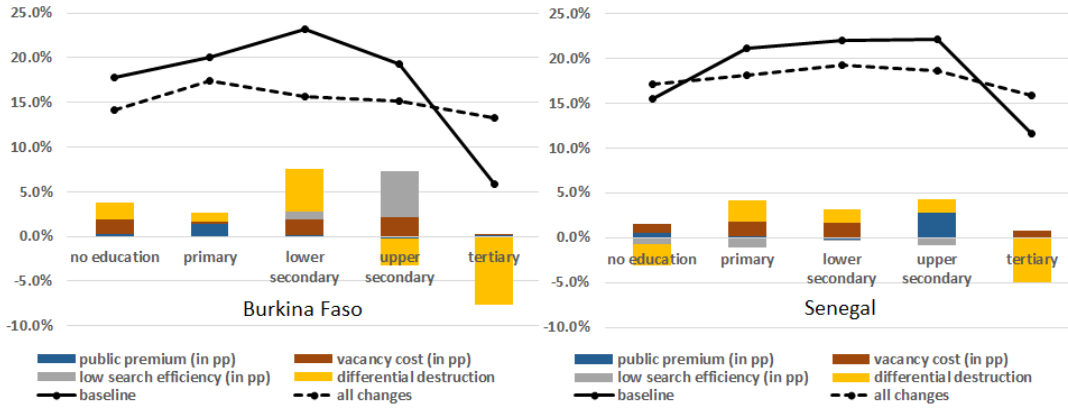
Figure 6: Contribution to educated unemployment in Burkina Faso (left) and Senegal (right)

is also fairly good. Mean incomes are somewhat too low for the public and private-formal sector for low education levels, but good for self-employment and intermediate and higher education levels. The first income percentile is generally well matched. The moments the model struggles the most to fit well are 3-year transition rates, especially transition out of unemployment. The model clearly underpredicts transition out of unemployment (especially towards self-employment).

6   Decomposing educated unemployment

In this section we quantify the contribution of different mechanisms to the phenomenon of educated unemployment. More specifically, we quantify the impact of the public sector premia, the large vacancy creation cost, the low search efficiency and education-specific job destruction. Figure 6 plots the education-specific unemployment rate in the baseline (black line) and an alternative scenario (dotted line). In the alternative scenario, the public sector does not pay any wage premia, vacancy posting costs are 33% lower, search efficiency would equal 50% and job-destruction would only differ by sector, but not by education. The bars display the respective contribution (in pp) of each factor.

The unemployment rate is in both countries hump-shaped in education. Hence, educated unemployment is present among those with intermediate (primary, lower secondary and upper secondary) education. In the alternative scenario, unemployment rates are grossly constant across education indicating that there is no longer any (or only little) educated unemployment.[20]

First, the contribution of public sector premia to educated unemployment is surprisingly small in both countries (except for those with upper secondary education in Senegal). In Burkina Faso, public sector premia are already small (see Table 7 in Appendix C) and hence, an elimination of these premia would only have a minor impact on unemployment. In Senegal, public wage premia are large for low (no education, primary) and upper secondary education. However, as those with low education only have a low probability of working in the public sector, the distortionary effect of these premia remains small. For those with upper secondary education, the public premium is

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[20]The shape of unemployment rates in the alternative scenario are to a large extent determined by differences in the productivity distributions across sectors and education levels and by the flow value of unemployment by education.

large and a considerable share of these individuals works in the public sector. Eliminating the premium would thus decrease the unemployment rate of this specific group by 2.8pp.

Secondly, a reduction in vacancy posting costs by 33% encurred by the private-formal sector would reduce unemployment rates of those with intermediate education and less in both countries. In Burkina Faso, education-specific unemployment rates would drop by up to 2.2pp while in Senegal, the reduction would amount to 1 to 1.6pp. As shown in Figure 4, the private-formal sector oftentimes pays incomes which are almost as high in the public sector. An increase in private-formal vacancies thus provides a valuable work alternative to the public sector and hereby lowers unemployment rates.

Thirdly, increasing search efficiency to 50% can have large positive effects such as for those with upper secondary education in Burkina Faso. But the effect can also be slightly negative as in the case of Senegal. Increasing search efficiency makes it more likely for workers to accept self-employment opportunities and as such, it reduces unemployment. At the same time, more workers search for private-formal and public sector jobs. If private vacancy creation does not increase sufficiently, the job finding rate for searching workers drops and hence, unemployment can increase as a result.

Finally, the largest contribution to educated unemployment comes from education-specific destruction rates. Those at the extremes of the education distribution mostly work in a sector which has relatively low destruction rates for either those without education (self-employment) or those with tertiary education (public sector). In contrast, those with intermediate education do not have the same job stability as they face relatively high destruction rates in all three sectors. All in all, a reduction in vacancy posting costs and general destruction rates have the largest impact on reducing educated unemployment in this context.

7 Evaluating the effect of public policies

Many Francophone West African government have recently announced or implemented labour market policies. These policies usually fall into one or several of the following categories:

1. Large recruitment programs in the public sector.

2. Creation of new employment agencies to act as meeting platform for employers and employees and, thus, increase search efficiency and reduce recruitment costs.

3. Direct or indirect subsidies to entrepreneurial projects.

Our framework allows us to simulate and contrast the effect of these different labour market reforms. Given that these reforms are specifically targeted at reducing (educated) unemployment, we analyse their effects mainly on unemployment rates by education groups. We also investigate their effects on worker allocation across sectors and on the wage distribution.

These labour market policies have a direct counterpart in our model framework: The large public recruitment programs are simulated as an increase in public vacancy creation v_g. The creation of employment agencies can be translated into a reduction in private vacancy posting costs c and an increased search efficiency ψ. Finally, direct and indirect subsidies to entrepreneurial projects can either be simulated as an increased offer arrival rate of self-employment opportunities λ_s or an increase in productivity in self-employment $\mu_s(y)$.

Concomitantly to labour market policies, governments in Francophone West africa have implemented in the first decade of the century large educational reforms to attain universal primary education by the year 2015, as stated in the United Nations' Millenium Development Goals. With our model, we can simulate the effect of this educational push on individual labour market outcomes. In the last simulation, we analyse the effects of a compulsory primary education reform. We assume that only 1% of individuals get less than primary education, while all other education levels grow proportionally.

7.1 Increasing public-sector vacancies

In the first simulation we study the effects of doubling public-sector vacancies in view of lowering unemployment and educated unemployment.

Doubling public-sector vacancies has a small, but negative effect on unemployment. Overall unemployment increases by 1.2pp in Burkina Faso and 0.5pp in Senegal (see Table 20 in Appendix E). Public sector employment and self-employment generally increase, while private-formal employment decreases in equilibrium. Moreover, the job arrival rates for searching workers falls slightly, as well as ϕ, the share of private sector vacancies (see Table 19 in Appendix E). In the case of Burkina Faso, doubling public sector vacancies totally crowds out the private-formal sector, ϕ drops to 0. In Senegal, it drops to 5%.

In general equilibrium the share of private sector vacancies adjusts by more than the direct effect (which would have resulted in a ϕ of 18% and 38%, respectively). Public sector vacancy creation has externalities on the private-formal sector. An increase in v_g leads to a lower contact rate for private-formal firms. Given that the public sector offers on average higher incomes than the private-formal sector (due to the public wage premium and higher productivity), workers prefer to work in the public sector and hence, the private-formal sector posts fewer vacancies. This secondary effect is larger than the primary effect, leading to a fall in job arrival rates for searching workers.

Moreover, the policy has important redistribution effects among the different education groups. Figure 7 shows the change in the unemployment rates by education, Figure 8 shows the wage distribution by education in the baseline and under the public vacancy policy.

All in all, the public vacancy creation policy benefits those who are the most likely to work in the public sector before the reform. In Burkina Faso, only those with with tertiary education see their unemployment rates decrease, while in Senegal all workers with lower secondary education
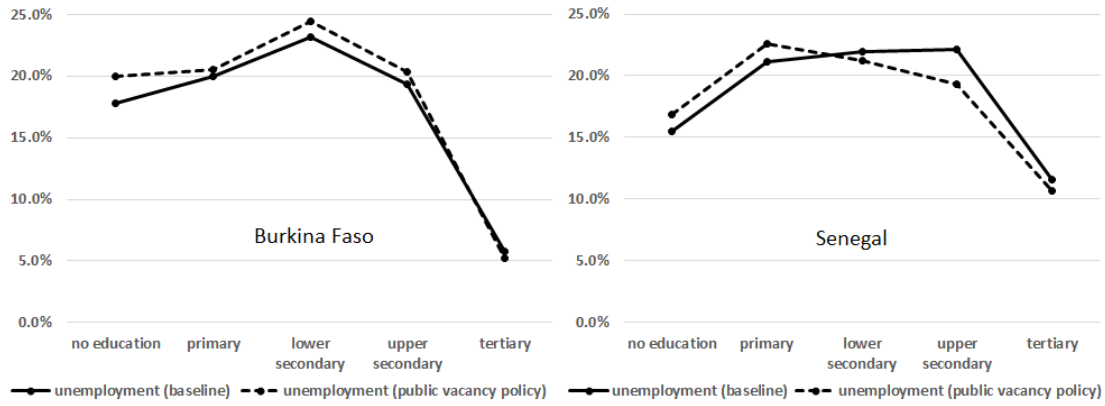
Figure 7: Unemployment before and after public vacancy creation

and more are affected. The policy boosts public-sector employment across all education groups, but it also crowds out private-formal vacancies. Those with intermediate education and less see their employment prospects in the private-formal sector collapse as a result of the reform. As a consequence, they find themselves in self-employment or even in unemployment. The improved employment perspectives in the public sector do not compensate for the lost formal-sector opportunities, so those with intermediate and less education are worse off in terms of unemployment.
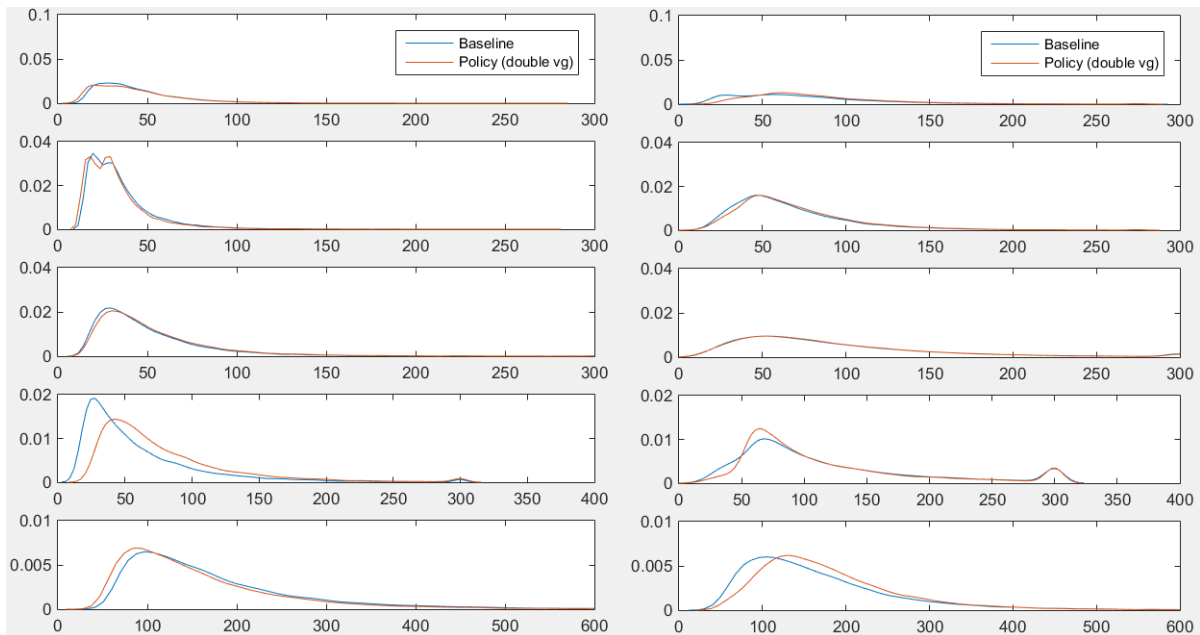
Figure 8: Wage distribution before and after public vacancy creation

Figure 8 shows the wage distribution conditional on employment in all sectors before (blue line) and after the policy (orange line). In Senegal, wages increase (or remain the same) for all education levels. Those at the extremes of the education distribution benefit the most. In Burkina Faso, only those with lower and upper secondary education see their average wages increase. Altogether, the public sector policy not only has redistributive effects in terms of employment and sectoral allocation, but also in terms of income. Certain groups benefit from the policy through lower unemployment, others through higher wages and some groups are

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worse off in both dimensions. All in all, the policy has clearly negative effects in Burkina Faso, where the share of public sector vacancy creation is already very high (at 70%) before the policy, while the effects are more nuanced in Senegal, where the public vacancy sector is initially lower.

This policy would increase the public wage bill by 36% in Burkina Faso, and by 97.5% in Senegal.[21]

7.2 Subsidising private-formal vacancy creation

The government have created or planned to establish new employment agencies in order to reduce recruitment costs for firms[22] and increase search efficiency. In this setting we study how a decrease of vacancy posting costs c by 33% would impact overall unemployment, educated unemployment, worker allocation across sectors and wages.

Figure 9 displays unemployment rates by education in the baseline (solid line) and after the policy which reduces vacancy posting costs by 33% (dotted line).
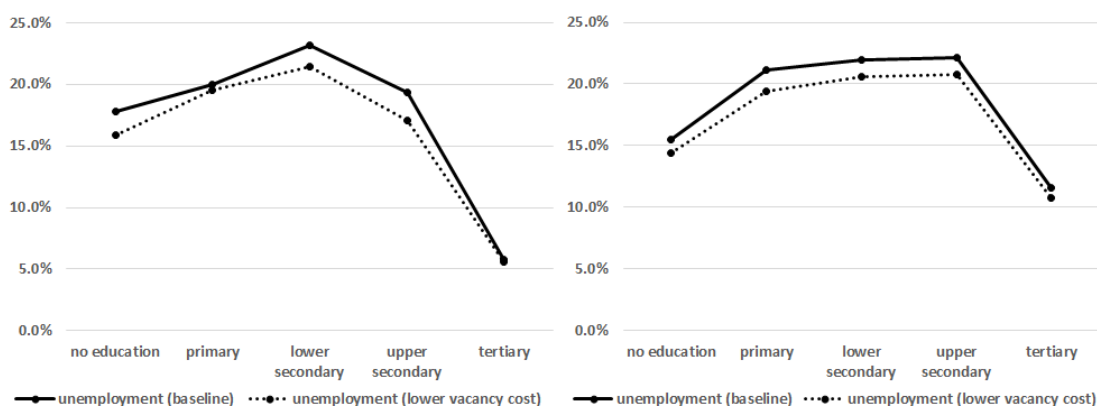
Figure 9: Unemployment before and after vacancy posting cost reduction

Overall unemployment decreases by approximately 1.3pp (from a baseline of 18.8%) in both countries (see Table 20 in Appendix E), while private sector employment in Burkina Faso doubles (from 14.9% to 29.6%) and in Senegal it increases by 10.5pp (from 19.4% to 29.9%). The vacancy cost reduction mostly translates into lower unemployment rates of those with upper secondary education and less. However, it does not specifically reduce educated unemployment, but rather lowers unemployment rates for all intermediate and low education levels. In contrast to the public vacancy creation policy presented above, it does not worsen employment prospects of any education group. Moreover, the policy not only reduces unemployment, but it also decreases the

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[21]The increase in the wage bill is smaller than 100% because the educational composition in the public sector shifts towards a lower average education level, for which average incomes are lower (i.e. the share of those with lower secondary education and less increase more). Moreover, the policy has for some education groups in Burkina Faso small negative income effects.

[22]Djankov et al. (2002) collect the number of procedures, official time (in days) and official cost (in % of GDP per capita) that a new business must bear before it can operate legally. For Burkina Faso, they report 14 procedures, 33 days and a cost of 332% GDP per capita. The respective numbers in Senegal are 16 procedures, 69 days and a cost of 151% of per capita GDP. Generally, Sub-Saharan countries are among the countries with most procedures and the largest cost.

share in self-employment and in the public sector employment (given that public vacancy creation has not increased). All in all, the job arrival rate for the public/formal sector increases from 0.19 to 0.25 in Burkina Faso and from 0.14 to 0.19 in Senegal (see Table 19 in Appendix E), as labour markets become less tight.

Figure 10 displays wage distribution conditional on employment in all sectors before (blue line) and after the policy (orange line).
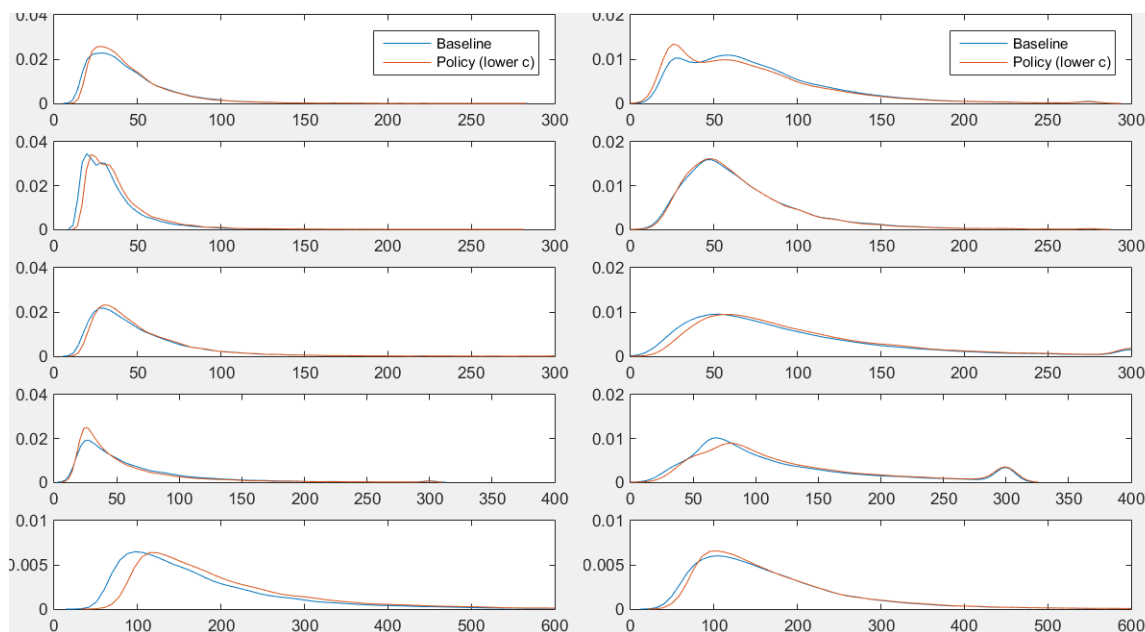
Figure 10: Wage distribution before and after vacancy cost reduction

In Burkina Faso, incomes increase at all education levels, the effect being largest for those at tertiary education. In Senegal, wages increase (or remain the same) for those with lower secondary education and more. Those without any education see their incomes slightly decrease. Contrary to the public sector vacancy creation policy studied above, this policy does not produce any unintended side effects. It stimulates private-sector employment, while reducing (low-paying) self-employment and unemployment. At the same time, it does not have major redistributive effects among education groups.

Altogether, the policy has unambigiously positive effects (both for lowering unemployment and increasing incomes) in Burkina Faso. The employment effects are also consistently positive in Senegal. However, the policy has a (very) slight negative effect on incomes for those without any education.

7.3 Facilitating entry into self-employment

A third pillar of recent public policies implemented to combat unemployment and educated unemployment are direct and indirect subsidies to entrepreneurial projects. In fact, as indicated by our relatively low estimates on the arrival rate of self-employment opportunities (0.23 in Burkina Faso and 0.17 in Senegal), there remain some important barriers to becoming a (income-earning)

entrepreneur. This is also reflected in the survey data, in which unemployed workers were asked why they did not start their own micro-company. The most common reason (chosen by more than 50%) for not starting a micro-company was 'It is not so easy.'[23] This evidence suggests that barriers to self-employment are consequential. Public policy could lower these barriers to self-employment by facilitating access to credit and markets, providing training in entrepreneurial skills, etc.

In this third simulation exercise we study the effects of an increased offer arrival rate of self-employment opportunities, i.e. if λ_s increased to 0.5. Figure 11 displays unemployment rates by education in the baseline (solid line) and after the policy which facilitates entry into self-employment (dashed-dotted line).
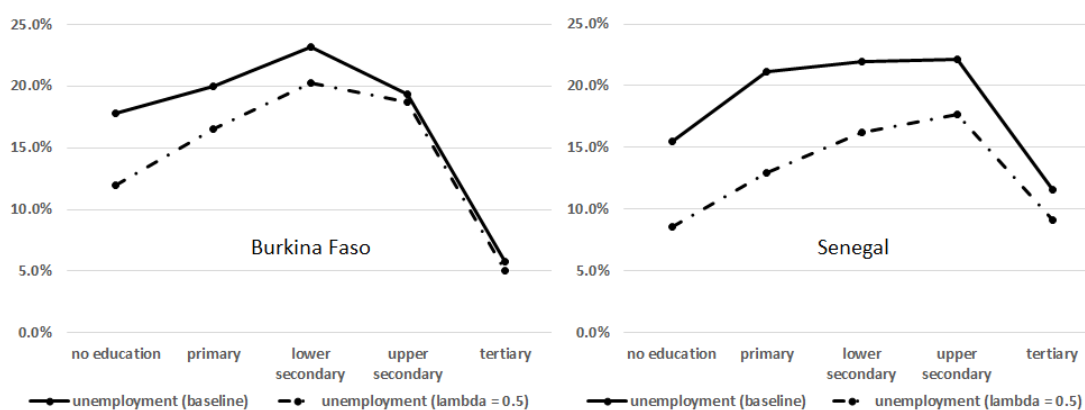
Figure 11: Unemployment before and after facilitating entry into self-employment

This policy has an important impact on overall unemployment, decreasing it by 3.7pp in Burkina Faso and by 6.5pp in Senegal (see Table 20 in Appendix E). While the policy effectively decreases unemployment rates, it is biased towards workers with lower secondary education and less, and as such, leaves educated unemployment unchanged (or makes it slightly worse in relative terms). Better access to self-employment raises the reservation income in the private-formal sector and thus leads to much lower vacancy posting by the private-formal sector (see Table 19 in Appendix E). Despite lower private-formal vacancy posting, labour market tightness only increases slightly given that a larger share of workers move into self-employment in which their search efficiency is much lower than when unemployed. Given the improved access to self-employment, the overall size of the workforce employed in the public sector shrinks. Those with lower secondary education and less are less likely to work in the public sector, while those with high education are more likely.

Figure 12 displays wage distribution conditional on employment in all sectors before (blue line) and after the self-employment enhancing policy (orange line).

The effect of this policy is unambigiously positive in terms of incomes in both countries and

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[23]Other reasons include low incomes (20%), mismatch with initial qualifications (8%), prevents from looking for better jobs (4%) and other reasons (15%).
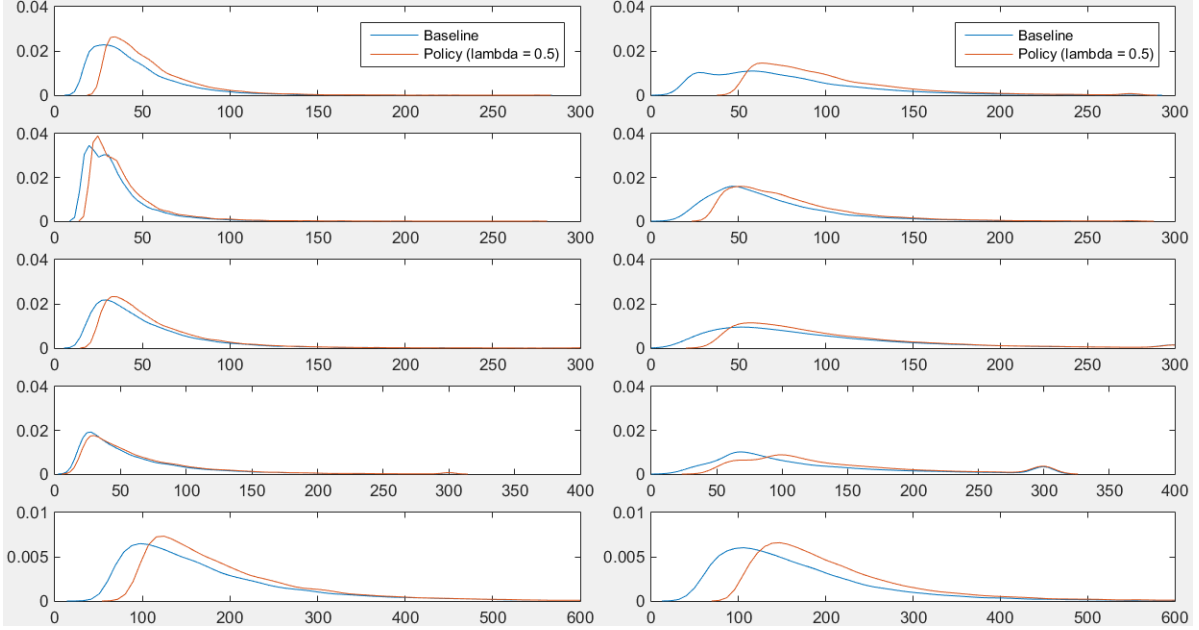
Figure 12: Wage distribution before and after facilitating entry into self-employment

for all education groups. This may come as a surprise as the ex-ante income distribution in self-employment is first-order stochastically dominated by the public or private-formal sector in several cases (see Figure 4 above). However, facilitating entry into self-employment raises considerably the reservation income both in self-employment and the private-formal sector and as a consequence, also incomes.

7.4 Compulsory primary education reform

In this last simulation exercise, we study the effect of a compulsory primary education reform. For this purpose we change the educational distribution $P(y)$ in such a manner as only 1% of all workers have less than primary education, while all other education levels grow proportionally.

The education reform translates into an overall increased unemployment rate. In Burkina Faso, unemployment rises by 0.5pp to 19.2%, and by 1.3pp to 20.1% in Senegal (see Table 20 in Appendix E). This main effect of the reform is a purely compositional effect as it pushes workers along the (mostly) increasing unemployment rate by education.

In equilibrium, the private-formal sector in Senegal neither increases nor decreases its vacancy posting in response to the policy (see Table 19 in Appendix E). As a consequence, neither education-specific incomes nor sectoral allocation change much. The overall accepted income distribution (across all sectors and education levels) is (very) slightly shifted to the right (see Figure 13, right panel) and first-order stochastically dominates the baseline distribution.

In Burkina Faso, the private-formal sector reacts by posting fewer vacancies after the education policy (see Table 19 in Appendix E). This might come as a surprise given that the average educational attainment of the worker pool increases, which would be expected to stimulate private-formal vacancy creation. However, the average productivity in the private-formal sector μ_p of a

worker without education is particularly high (see Table 8) and exceeds the average productivity of workers with primary or upper secondary education. Moreover, the former have a lower reservation income than the later, resulting in larger profits for the private-formal sector. An increase in the worker pool's education thus decreases profits and hence, the private-formal sector reacts by posting fewer vacancies. As shown in the overall accepted income distribution (see Figure 13, right panel)the share of low incomes remains the same, while the share of intermediate incomes slightly decreases and the share of high incomes slightly increases.
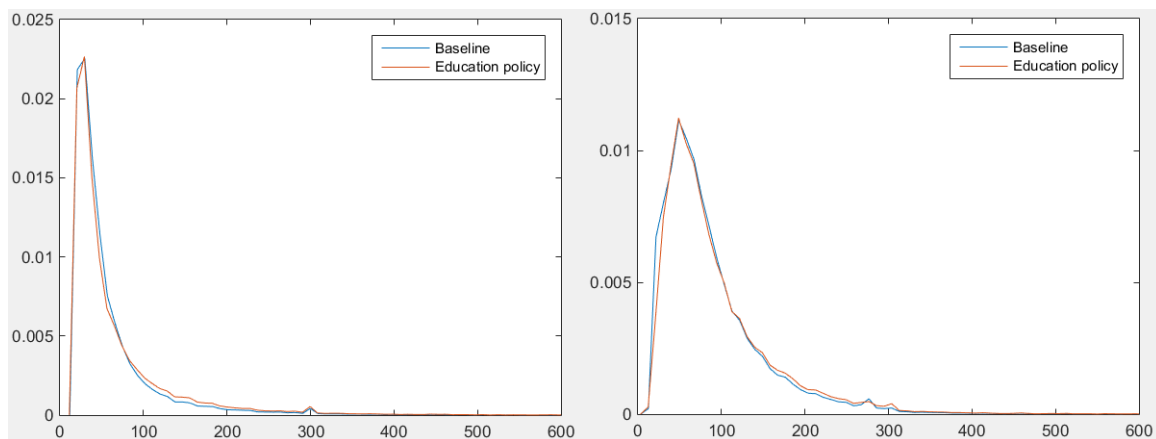
Figure 13: Wage distribution in the baseline and after the education reform in Burkina Faso (left) and Senegal (right)

All in all, from the perspective of labour market outcomes, this policy is detrimental in terms of increasing unemployment (mainly through compositional effects) and only marginally increasing incomes.

8 Conclusion

The unemployment rates in urban West Africa are increasing or hump-shaped in education, in sharp contrast to the decreasing pattern found for developed countries. This raises the key question of why educated workers refrain from downgrading to self-employment. Governments in Francophone West Africa take an active role in combatting (educated) unemployment by creating public jobs, establishing new employment agencies and subsidising entrepreneurial projects. However, the role of the public sector is questioned as it might contribute to the problem through distortions rather than helping to resolve it.

In this paper, we shed light on the workings of the West African (urban) labour market by describing the heterogeneity across employment sectors and education groups. We then develop and estimate a general equilibrium search and matching model with heterogeneous workers and a labour market with three sectors (public, private-formal and self-employment) that mimic well the observed patterns. High frictions (through high private-formal vacancy posting costs and low search efficiency when self-employed) and differential job destruction are the main determinants of educated unemployment. Public wage premia are relatively high (especially

in Senegal, and more so for lower education levels), but their overall distortionary effects are small because these worker groups are unlikely to enter the public sector (even without the premia).

We use our framework to study how recent (and planned) labour market and education public policies affect (educated) unemployment, sectoral allocation of workers and incomes. We simulate the effects of public sector vacancy creation, a reduction in private-formal vacancy posting costs and subsidies to entrepreneurial projects which facilitate becoming self-employed. Doubling public sector vacancies results in increased overall unemployment rates both in Burkina Faso and Senegal. Public vacancy creation imposes a negative externality on the private-formal sector (through lower contact rates with workers), which results in a crowding out of the private-formal sector by the public sector. Given that the public sector mostly hires workers with intermediate or high education, the policy also has important redistributive effects from those with little (or no) education towards those with upper secondary or tertiary education. Subsidies to private-formal vacancy posting costs or lowering barriers to self-employment, in contrast, effectively lower unemployment. Moreover, these policies reduce unemployment among all education groups and lead to higher average incomes. The result of the entrepreneurial subsidies is particularly interesting because incomes in self-employment are ex-ante generally lower than in the other sectors. Surprisingly, facilitating entry into self-employment does not push workers into low-income self-employment, but instead it allows unemployed workers to become more picky about which self-employment opportunities to take up, leading to higher self-employment incomes and lower unemployment.

Our policy simulations suggest that the recent public recruitment programmes in West Africa are an inappropriate tool (in itself) to combat overall or educated unemployment. Current public vacancy posting is not particularly high, but private-formal vacancy posting costs are massive. It is important that governments in West Africa improve the conditions for doing business (both formal and informal businesses), so as to stimulate job creation which is necessary to absorb the steadily growing labour force in these countries.

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A Appendix: Derivation of the Wages and Reservation Productivities

A.1 Private-formal wage rule after unemployment

In the private-formal sector, wages are determined by Nash bargaining. The worker's bargaining power is given by β. The worker bargains with the present value of unemployment as an outside option, while the private-formal firm's surplus is the value of a filled job. The Nash bargaining solution thus has to solve the problem:

$$\max_{w} \left(V_p(x,y) - V_U(y)\right)^{\beta} J_u(x,y)^{1-\beta} \tag{32}$$

Rearranging equation (2) gives the unemployed worker's surplus from accepting a private-formal job with productivity x. Similarly, we can rearrange equation (8) to get the present value of a job filled by a previously unemployed worker for a private-formal firm. It follows that:

$$w_p(x,y) = \beta x + (1-\beta)rV_U(y) \tag{33}$$

Denote by $R_j(y)$, the reservation productivity to work in the sector j. In each sector it must satisfy:

$$V_j\left(R_j(y),y\right) = V_U(y), \ j \in \{p,s\} \tag{34}$$

$$V_{p,s}\left(R_{p,s}(x_s,y),x_s,y\right) = V_s(x_s,y) \tag{35}$$

$$R_g(y) = w_g\left(R_g(y),y\right) \tag{36}$$

$$V_{g,s}\left(\tilde{R}_{g,s}(x_s,y),x_s,y\right) = V_s(x_s,y) \tag{37}$$

$$R_{g,s}(x_s,y) = max\left(\tilde{R}_{g,s}(x_s,y),R_g(y)\right) \tag{38}$$

The reservation productivity in the private-formal sector and self-employment (equation (34)) is such that the worker is indifferent between accepting a job at productivity x and remaining in unemployment. The reservation productivity of transiting from self-employment to private-formal employment is when the worker is indifferent between accepting the new private-formal job and remaining in self-employment (equation (35)). Equation (36) is the reservation productivity in the public sector. Finally, the reservation productivity in the public sector coming from self-employment is the maximum of the public sector's reservation productivity (equation (36)) and the worker's reservation productivity (equation (37)).

Introducing equation (33) into a rearranged version of equation (2), and using the definition of the private-formal reservation productivity (equation(34)) we obtain

$$R_p(y) = rV_U(y) \tag{39}$$

Using this result, we can derive the wage rule in the private-formal sector as:

$$w_p(x,y) = \beta x + (1-\beta)R_p(y) \tag{40}$$

Furthermore, using the characterization of the reservation productivity in each sector given y, and equations (2) and (3), we obtain:

$$V_p(x,y) - V_U(y) = \frac{\beta}{r + \delta_p(y)}(x - R_p(y)) \tag{41}$$

$$V_g(x,y) - V_U(y) = \frac{1}{r + \delta_g(y)}(w_g(x,y) - R_p(y)) \tag{42}$$

A.2 Private-formal wage rule after self-employment and reservation productivities

For a transition from self-employment to the private sector, the worker bargains with the present value of self-employment as an outside option. The private-formal wage is thus the solution to the following Nash bargaining problem:

$$\max_w (V_{p,s}(x,x_s,y) - V_s(x_s,y))^\beta J_s(x,x_s,y)^{1-\beta} \tag{43}$$

The worker's surplus from self-employment compared to unemployment is given by equation (4). Rearranging terms, this reads as:

$$V_{p,s}(x,x_s,y) - V_U(y) = \frac{w_{p,s}(x,x_s,y) - rV_U(y)}{r + \delta_p(y)} \tag{44}$$

Subtracting the flow value of self-employment on both sides and rearranging terms, we can derive the worker's surplus of moving from self-employment to private-formal employment as:

$$V_{p,s}(x,x_s,y) - V_s(x_s,y) = \frac{w_{p,s}(x,x_s,y) + \delta_p(y)V_U(y) - (r + \delta_p(y))V_s(x_s,y)}{r + \delta_p(y)} \tag{45}$$

Substituting the worker's surplus (equation (45)) and the firm's surplus from a filled job (rearranging equation (9)) into the Nash bargaining problem, deriving the first order condition and rearranging terms leads to the following wage equation:

$$w_{p,s}(x,x_s,y) = \beta x + (1-\beta)\left[rV_U(y) + (r + \delta_p(y))(V_s(x_s,y) - V_U(y))\right] \tag{46}$$

The first two components of the wage rule of a worker in a private-formal firm who was previously self-employed is identical to the wage rule of one who was unemployed. However, the previously self-employed worker additionally receives a fraction of the value of the surplus from self-employment (compared to unemployment). At the reservation productivity in self-employment $R_s(y)$, the surplus from self-employment is 0, and hence, the wage rule is the same as of an unemployed worker.

Using the characterization of the reservation wage and equation (44), it follows immediately that:

$$V_{p,s}(R_{p,s}(x_s,y), x_s, y) - V_U(y) = V_s(x_s,y) - V_U(y) = \frac{R_{p,s}(x_s,y) - R_p(y)}{r + \delta_p(y)} \tag{47}$$

Hence:

$$V_{p,s}(x,x_s,y) - V_s(x_s,y) = \frac{\beta}{r + \delta_p(y)}(x - R_{p,s}(x_s,y)) \tag{48}$$

Using equation (5) and equation (47), we obtain:

$$V_{g,s}(x, x_s, y) - V_s(x_s, y) = \frac{1}{r + \delta_g(y)} \left(w_g(x, y) - R_p(y) - \frac{r + \delta_g(y)}{r + \delta_p(y)} [R_{p,s}(x_s, y) - R_p(y)] \right) \quad (49)$$

Using again equation (35), equation (6), and the two previous expressions, we can characterize $R_{p,s}(x_s, y)$ and $R_{g,s}(x_s, y)$:

$$
\begin{aligned}
R_{p,s}(x_s, y) &= R_p(y) + \frac{r + \delta_p(y)}{r + \delta_s(y)} (x_s - R_p(y)) + \frac{\lambda_{p,s}(y)\beta}{r + \delta_s(y)} \int_{R_{p,s}(x_s,y)} [x - R_{p,s}(x_s, y)]\ dF_{X,p}(x|y) \\
&+ \frac{r + \delta_p(y)}{r + \delta_s(y)} \frac{\lambda_{g,s}(y)}{r + \delta_g(y)} \int_{R_{g,s}(x_s,y)} [w_g(x, y) - R_p(y)]\ dF_{X,g}(x|y) \\
&- \frac{\lambda_{g,s}(y) [1 - F_{X,g}(R_{g,s}(x_s, y)|y)]}{r + \delta_s(y)} [R_{p,s}(x_s, y) - R_p(y)] \quad (50)
\end{aligned}
$$

and

$$\tilde{R}_{g,s}(x_s, y) = R_p(y) + \frac{1}{\gamma} \left[\frac{r + \delta_g(y)}{r + \delta_p(y)} [R_{p,s}(x_s, y) - R_p(y)] - \pi(y) \right] \quad (51)$$

$$R_{g,s}(x_s, y) = max\left(\tilde{R}_{g,s}(x_s, y), R_g(y) \right) \quad (52)$$

To characterize $R_s(y)$ and $R_p(y)$, note first that from equation (35) and equation (47), $R_{p,s}(R_s(y), y) = R_p(y)$. Substituting this result into equation (50), we note that the left-hand side and the last term of the right-hand side of this equation are 0. Hence, the reservation productivity in self-employment is given by:

$$
\begin{aligned}
R_s(y) &= R_p(y) - \frac{\lambda_{p,s}\beta}{r + \delta_p(y)} \int_{R_p(y)} [x - R_p(y)]\ dF_{X,p}(x|y) \\
&- \frac{\lambda_{g,s}}{r + \delta_g(y)} \int_{R_{g,s}(R_s(y),y)} [w_g(x, y) - R_p(y)]\ dF_{X,g}(x|y) \quad (53)
\end{aligned}
$$

Note that the reservation wage for self-employment is lower than the reservation wage for employment in the private sector. That is because the self-employed present value accounts for the possible transition in the future. Finally, using equation (1), we obtain:

$$
\begin{aligned}
R_p(y) &= b(y) + \frac{\lambda_{p,u}\beta}{r + \delta_p(y)} \int_{R_p(y)} [x - R_p(y)]\ dF_{X,p}(x|y) \\
&+ \frac{\lambda_{g,u}}{r + \delta_g(y)} \int_{R_g(y)} [w_g(x, y) - R_p(y)]\ dF_{X,g}(x|y) \\
&+ \frac{\lambda_s}{r + \delta_p(y)} \int_{R_s(y)} [R_{p,s}(x, y) - R_p(y)]\ dF_{X,s}(x|y) \quad (54)
\end{aligned}
$$

since $R_{p,s}(R_s(y), y) = R_p(y)$.

For given values of $\lambda_{p,u}$ and $\lambda_{g,u}$, there exists a unique solution for $R_p(y)$. Indeed, the RHS is positive at $R_p(y) = 0$, goes to b as $R_p(y) \to +\infty$ and is decreasing in $R_p(y)$.

The private-sector wage rule equation upon transition from self-employment (see equation (46) above) can be simplified using the results that $rV_U(y) = R_p(y)$ and equation (47). It results in:

$$w_{p,s}(x, x_s, y) = \beta x + (1 - \beta)R_{p,s}(x_s, y) \tag{55}$$

Finally, the reservation productivity in the public sector is equal to:

$$R_g(y) = \frac{\pi(y)}{1 - \gamma} + R_p(y) \tag{56}$$

B   Appendix: Extending the model to endogenous schooling decision

Let a be the ability of an agent, with distribution function F_A, and k the family capital, with distribution function F_K, which summarizes the family background of the individual. The household chooses the optimal human capital of the individual h, so to solve the following problem:

$$\max_h V_U(h, k) - c(a, k).h \tag{57}$$

where $V_U(h, k)$ is the net present value of unemployment of an individual with human capital h and family capital k. $c(a, k)$ is the constant marginal cost of an additional year of education for an individual with ability a and family capital k.

In the subsequent analysis, we derive the present value of unemployment in general equilibrium (GE) model. To simplify notations, we refer to $y = (h, k)$, with distribution F_Y.

C Appendix: Estimation results

| | Burkina | | Senegal | |
	Observed	Educ. Pol.	Observed	Educ. Pol.
No education	0.35	0.01	0.28	0.01
Primary	0.25	0.38	0.34	0.47
Lower sec.	0.23	0.34	0.21	0.29
Higher sec.	0.09	0.13	0.07	0.09
Tertiary	0.09	0.13	0.10	0.14

Table 6: Observed educational distribution $P(y)$

| | Burkina | | | | Senegal | | | |
	$R_p(y)$	$\pi(y)$	$R_g(y)$	$R_s(y)$	$R_p(y)$	$\pi(y)$	$R_g(y)$	$R_s(y)$
No education	15.2	1.0	17.2	14.6	20.2	13.2	46.5	18.0
Primary	15.9	6.0	27.9	14.7	12.0	14.4	40.9	7.6
Lower secondary	18.9	1.6	21.8	15.5	25.1	2.3	29.7	14.9
Higher secondary	20.8	0.0	20.8	15.8	24.9	16.5	57.9	14.3
Tertiary	63.1	0.0	63.1	45.9	61.6	4.4	70.4	47.8

Notes: $R_p(y)$ and $\pi(y)$ are estimated parameters.
$R_g(y)$ and $R_s(y)$ are determined by $R_p(y)$ and $\pi(y)$ and other estimated parameters.

Table 7: Estimated reservation productivity and public wage premium (in 1,000 CFA/month)

| | Burkina | | | | | | Senegal | | | | | |
| | Public | | Formal | | Self | | Public | | Formal | | Self | |
	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ	σ
No education	2.27	0.72	3.92	0.57	3.71	0.53	4.52	0.68	3.03	0.56	4.28	0.53
Primary	3.28	0.61	3.87	0.65	2.94	0.74	4.39	0.69	4.49	0.55	4.12	0.52
Lower sec.	4.35	0.70	4.07	0.71	3.47	0.65	5.05	0.68	5.06	0.76	4.05	0.71
Higher sec.	4.60	0.76	3.38	0.91	1.95	0.87	4.21	1.19	5.06	0.87	4.49	0.67
Tertiary	5.29	0.75	5.68	0.75	5.07	0.50	5.57	0.52	5.06	0.88	4.80	0.71

Table 8: Estimated productivity parameters

Parameter	Description	Burkina	Senegal
$q(\kappa)/\kappa$	Offer arrival rate	0.19	0.14
κ	LM tightness: searchers per vacancy	26.8	47.7
ϕ	Fraction formal-sector vacancies	0.31	0.56
λ	Offer arrival rate self-employment	0.23	0.17
ψ	Search efficiency	0.09	0.14
c	Vacancy flow cost	973.5	2496.0
$\hat{w}_p$	Mean private-formal wage	55.7	88.6
v_g	Public-sector vacancies	0.59%	0.23%

Table 9: Estimated arrival parameters

	Burkina			Senegal		
	Public	Formal	Self	Public	Formal	Self
	$\delta_g(y)$	$\delta_p(y)$	$\delta_s(y)$	$\delta_g(y)$	$\delta_p(y)$	$\delta_s(y)$
No education	0.12	0.09	0.07	0.16	0.07	0.04
Primary	0.12	0.09	0.05	0.17	0.09	0.06
Lower sec.	0.11	0.09	0.12	0.07	0.08	0.09
Higher sec.	0.05	0.04	0.06	0.03	0.08	0.15
Tertiary	0.01	0.03	0.08	0.02	0.03	0.06

Table 10: Estimated destruction rates

	Burkina	Senegal
No education	-36.4	-68.9
Primary	-13.1	-80.8
Lower sec.	-40.0	-95.9
Higher sec.	-36.4	-112.3
Tertiary	-286.9	-156.2

Table 11: Resulting estimated unemployment benefits

D   Appendix: Goodness of Fit

	BF			SE		
	Data	StdErr	Model	Data	StdErr	Model
Unemployment rate						
No education	0.178	0.002	0.178	0.159	0.002	0.155
Primary	0.204	0.002	0.200	0.211	0.002	0.211
Lower secondary	0.242	0.002	0.232	0.225	0.002	0.220
Upper secondary	0.199	0.003	0.193	0.221	0.004	0.221
Tertiary	0.063	0.002	0.058	0.119	0.002	0.116
Share in public sector						
No education	0.066	0.012	0.048	0.051	0.010	0.070
Primary	0.127	0.019	0.103	0.064	0.011	0.064
Lower secondary	0.216	0.026	0.286	0.182	0.023	0.203
Upper secondary	0.416	0.045	0.507	0.225	0.043	0.319
Tertiary	0.582	0.039	0.631	0.341	0.034	0.360
Share in private-formal sector						
No education	0.119	0.015	0.150	0.130	0.016	0.113
Primary	0.136	0.020	0.148	0.204	0.018	0.199
Lower secondary	0.186	0.025	0.140	0.295	0.026	0.241
Upper secondary	0.208	0.039	0.165	0.337	0.047	0.244
Tertiary	0.208	0.034	0.158	0.406	0.035	0.271
Share in self-employment						
No education	0.636	0.018	0.624	0.660	0.018	0.662
Primary	0.532	0.025	0.549	0.521	0.020	0.526
Lower secondary	0.356	0.029	0.342	0.297	0.026	0.336
Upper secondary	0.177	0.037	0.135	0.218	0.043	0.216
Tertiary	0.147	0.029	0.153	0.134	0.025	0.253

Table 12: Fit: Unemployment and sectoral employment shares by education

	BF			SE		
	Data	StdErr	Model	Data	StdErr	Model
Educational composition in unemployment						
No education	0.313	0.022	0.330	0.221	0.018	0.229
Primary	0.270	0.021	0.271	0.386	0.021	0.386
Lower secondary	0.302	0.021	0.282	0.257	0.019	0.245
Upper secondary	0.091	0.013	0.091	0.079	0.011	0.078
Tertiary	0.024	0.007	0.026	0.057	0.010	0.062
Educational composition in public sector						
No education	0.121	0.018	0.081	0.117	0.020	0.138
Primary	0.168	0.020	0.126	0.176	0.023	0.156
Lower secondary	0.246	0.023	0.316	0.300	0.028	0.301
Upper secondary	0.191	0.021	0.216	0.117	0.020	0.149
Tertiary	0.275	0.024	0.261	0.289	0.027	0.256
Educational composition in private-formal sector						
No education	0.273	0.027	0.349	0.161	0.016	0.162
Primary	0.223	0.025	0.251	0.300	0.020	0.353
Lower secondary	0.263	0.026	0.213	0.261	0.019	0.261
Upper secondary	0.119	0.019	0.097	0.094	0.013	0.083
Tertiary	0.122	0.020	0.090	0.184	0.017	0.141
Educational composition in self-employment						
No education	0.483	0.017	0.473	0.415	0.016	0.387
Primary	0.288	0.016	0.303	0.390	0.015	0.381
Lower secondary	0.167	0.013	0.170	0.134	0.011	0.148
Upper secondary	0.033	0.006	0.026	0.031	0.005	0.030
Tertiary	0.029	0.006	0.028	0.031	0.005	0.054

Table 13: Fit: Educational composition of each sector

	BF			SE		
	Data	StdErr	Model	Data	StdErr	Model
Mean monthly income in public sector (in 1000 CFA)						
No education	64.6	5.7	23.0	101.8	7.3	90.9
Primary	72.8	4.3	38.1	116.2	9.8	74.5
Lower secondary	91.6	4.6	60.9	145.9	10.3	113.0
Upper secondary	89.6	7.1	75.3	136.6	13.1	126.4
Tertiary	176.9	11.0	169.2	247.6	17.1	187.3
Std. dev. of monthly income in public sector (in 1000 CFA)						
No education	37.2	3.8	4.6	41.1	4.1	37.6
Primary	32.9	4.1	14.3	67.9	12.5	39.9
Lower secondary	42.4	2.3	35.0	93.7	12.2	64.0
Upper secondary	57.3	7.6	51.2	74.2	8.2	71.4
Tertiary	107.0	13.1	102.3	154.5	26.2	82.4
First percentile of monthly income in public sector (in 1000 CFA)						
No education	16.0	4.6	17.3	40.0	3.6	47.8
Primary	20.0	4.5	27.9	37.0	2.9	41.2
Lower secondary	17.0	2.9	23.5	27.0	15.1	35.5
Upper secondary	20.0	1.4	21.9	58.5	0.2	58.4
Tertiary	66.0	0.3	65.8	70.0	12.4	79.4
Mean monthly income in private-formal sector (in 1000 CFA)						
No education	49.0	3.3	33.8	82.1	5.4	25.2
Primary	51.5	3.4	41.9	91.8	5.0	60.1
Lower secondary	63.0	4.7	47.8	118.4	7.0	110.4
Upper secondary	82.6	12.2	42.2	125.8	13.2	119.3
Tertiary	254.3	25.8	234.2	304.3	24.1	174.6
Std. dev. of monthly income in private-formal sector (in 1000 CFA)						
No education	28.9	3.5	13.8	48.8	6.7	4.8
Primary	27.1	3.3	22.9	62.3	7.2	31.4
Lower secondary	39.8	4.4	33.1	80.7	7.0	75.5
Upper secondary	69.8	12.5	24.9	91.3	14.0	77.2
Tertiary	150.2	15.8	154.7	233.9	23.7	137.2
First percentile of monthly income in private-formal sector (in 1000 CFA)						
No education	15.0	1.1	16.6	20.0	5.8	20.4
Primary	15.0	1.0	17.9	23.0	3.4	22.2
Lower secondary	15.0	2.6	19.2	35.0	3.4	28.5
Upper secondary	24.0	1.5	21.1	25.0	4.6	29.3
Tertiary	66.0	13.1	70.5	60.0	2.8	62.9

Table 14: Fit: Incomes in public and private-formal sector

	BF			SE		
	Data	StdErr	Model	Data	StdErr	Model
Mean monthly income in self-employment (in 1000 CFA)						
No education	48.2	1.5	47.4	80.6	2.6	81.7
Primary	45.3	1.9	33.5	70.5	2.2	70.0
Lower secondary	51.1	2.9	42.0	86.0	5.8	71.1
Upper secondary	63.1	9.4	28.5	112.7	13.6	111.0
Tertiary	196.2	23.9	184.6	248.4	38.3	161.6
Std. dev. of monthly income in self-employment (in 1000 CFA)						
No education	30.5	1.7	25.4	52.7	3.5	44.6
Primary	29.4	2.0	22.2	44.4	3.5	40.3
Lower secondary	34.6	2.6	24.3	67.4	9.4	49.5
Upper secondary	49.8	14.6	12.8	75.4	9.4	65.6
Tertiary	116.9	28.1	89.5	213.1	53.0	98.4
First percentile of monthly income in self-employment (in 1000 CFA)						
No education	15.0	0.2	15.4	20.0	1.5	22.2
Primary	15.0	0.1	15.0	20.0	0.2	20.0
Lower secondary	15.0	0.4	16.8	20.0	2.0	18.8
Upper secondary	20.0	1.7	16.2	25.0	12.4	20.7
Tertiary	66.0	6.9	56.6	70.0	11.9	48.2

Table 15: Fit: Incomes in self-employment

	BF			SE		
	Data	StdErr	Model	Data	StdErr	Model
Mean monthly income in public sector conditional on past self-employment (in 1000 CFA)						
No education	41.8	4.0	31.5	97.2	22.4	126.0
Primary	65.1	8.3	39.2	116.1	37.7	119.1
Lower secondary	66.3	10.9	86.3	75.9	17.8	147.0
Upper secondary	100.0	18.5	88.1	190.0	110.0	125.2
Tertiary	328.3	114.3	259.4	291.2	72.5	227.8
Mean monthly income in private-formal sector conditional on past self-employment (in 1000 CFA)						
No education	47.3	5.7	61.4	74.3	7.3	47.0
Primary	47.3	8.1	56.5	82.0	7.1	109.3
Lower secondary	60.2	8.4	84.3	105.0	13.5	157.3
Upper secondary	32.0	4.2	40.2	138.8	39.9	181.8
Tertiary	132.0	100.0	340.3	88.5	28.5	273.7

Table 16: Fit: Incomes in public and private-formal sector conditional on previous self-employment

		Current state											
		Unemployed			Public			Private-formal			Self-employed		
Past state		Data	StdErr	Model	Data	StdErr	Model	Data	StdErr	Model	Data	StdErr	Model
No education													
Unemployed		54.0%	2.1%	93.3%	1.7%	0.5%	0.0%	3.9%	0.8%	2.2%	40.4%	2.1%	4.5%
Public		20.5%	4.8%	27.1%	65.8%	5.6%	66.7%	1.4%	1.4%	0.0%	12.3%	3.9%	6.3%
Private		11.0%	3.5%	22.0%	0.0%	n.a.	0.0%	82.9%	4.2%	78.0%	6.1%	2.7%	0.0%
Self-employed		6.6%	0.9%	8.0%	0.4%	0.2%	0.0%	0.5%	0.2%	0.6%	92.6%	0.9%	91.3%
Primary													
Unemployed		59.8%	2.4%	92.5%	1.5%	0.6%	2.5%	3.6%	0.9%	2.5%	35.1%	2.4%	2.5%
Public		17.9%	4.4%	24.3%	71.8%	5.1%	73.8%	2.6%	1.8%	1.0%	7.7%	3.0%	1.0%
Private		15.4%	4.1%	21.1%	0.0%	1.0%	0.0%	78.2%	4.7%	78.9%	6.4%	2.8%	0.0%
Self-employed		6.7%	1.2%	7.5%	0.5%	0.3%	1.5%	0.2%	0.2%	1.1%	92.6%	1.3%	90.0%
Lower secondary													
Unemployed		68.6%	2.4%	97.0%	6.7%	1.3%	1.7%	6.9%	1.3%	0.4%	17.8%	2.0%	0.9%
Public		4.5%	2.0%	28.7%	91.9%	2.6%	71.3%	0.0%	n.a.	0.0%	3.6%	1.8%	0.0%
Private		17.8%	4.1%	23.6%	1.1%	1.1%	0.0%	75.6%	4.6%	76.4%	5.6%	2.4%	0.0%
Self-employed		6.2%	2.0%	24.3%	2.8%	1.4%	2.0%	2.8%	1.4%	0.3%	88.3%	2.7%	73.4%
Upper secondary													
Unemployed		49.5%	5.0%	92.7%	27.2%	4.4%	6.2%	10.7%	3.1%	1.0%	12.6%	3.3%	0.0%
Public		1.6%	1.6%	12.6%	98.4%	1.6%	86.8%	0.0%	1.0%	0.2%	0.0%	1.0%	0.4%
Private		11.9%	5.1%	10.3%	7.1%	4.0%	1.8%	78.6%	6.4%	87.9%	2.4%	2.4%	0.0%
Self-employed		14.8%	7.0%	11.1%	18.5%	7.6%	2.2%	11.1%	6.2%	1.5%	55.6%	9.7%	85.2%
Tertiary													
Unemployed		32.6%	7.2%	98.3%	34.9%	7.4%	1.7%	23.3%	6.5%	0.0%	9.3%	4.5%	0.0%
Public		0.0%	n.a.	3.2%	100.0%	n.a.	96.8%	0.0%	n.a.	0.0%	0.0%	n.a.	0.0%
Private		5.3%	3.7%	4.4%	5.3%	3.7%	0.0%	81.6%	6.4%	95.6%	7.9%	4.4%	0.0%
Self-employed		14.8%	7.0%	15.0%	25.9%	8.6%	0.7%	11.1%	6.2%	1.3%	48.1%	9.8%	83.0%

Table 17: 3-year labour market transition rates in Burkina Faso

	Current state											
	Unemployed			Public			Private-formal			Self-employed		
Past state	Data	StdErr	Model	Data	StdErr	Model	Data	StdErr	Model	Data	StdErr	Model
No education												
Unemployed	56.0%	2.4%	96.8%	0.7%	0.4%	0.0%	3.2%	0.8%	1.3%	40.2%	2.3%	1.9%
Public	29.9%	5.2%	35.7%	54.5%	5.7%	62.9%	1.3%	1.3%	0.0%	14.3%	4.0%	1.4%
Private	8.6%	2.7%	16.8%	0.0%	n.a.	0.0%	84.8%	3.5%	83.2%	6.7%	2.4%	0.0%
Self-employed	4.6%	0.7%	4.2%	0.0%	n.a.	0.4%	0.2%	0.2%	0.0%	95.1%	0.8%	95.3%
Primary												
Unemployed	64.0%	2.0%	99.5%	1.6%	0.5%	0.0%	6.4%	1.0%	0.0%	28.1%	1.9%	0.5%
Public	21.7%	4.3%	32.8%	59.8%	5.1%	67.2%	6.5%	2.6%	0.0%	12.0%	3.4%	0.0%
Private	12.7%	2.6%	25.6%	2.4%	1.2%	0.0%	80.0%	3.1%	74.4%	4.8%	1.7%	0.0%
Self-employed	7.3%	1.0%	10.5%	0.3%	0.2%	0.2%	2.5%	0.6%	2.5%	89.9%	1.2%	86.9%
Lower secondary												
Unemployed	64.8%	2.7%	99.5%	5.5%	1.3%	0.5%	13.2%	1.9%	0.0%	16.5%	2.1%	0.0%
Public	4.0%	1.8%	19.7%	90.3%	2.7%	80.3%	0.8%	0.8%	0.0%	4.8%	1.9%	0.0%
Private	14.0%	2.8%	19.1%	0.0%	n.a.	0.0%	80.9%	3.1%	80.9%	5.1%	1.8%	0.0%
Self-employed	10.3%	2.2%	20.5%	2.2%	1.1%	2.1%	4.3%	1.5%	1.2%	83.2%	2.8%	76.2%
Upper secondary												
Unemployed	59.3%	5.3%	99.5%	10.5%	3.3%	0.0%	26.7%	4.8%	0.0%	3.5%	2.0%	0.5%
Public	0.0%	n.a.	6.9%	100.0%	n.a.	93.1%	0.0%	n.a.	0.0%	0.0%	n.a.	0.0%
Private	13.5%	4.8%	21.3%	0.0%	n.a.	0.0%	84.6%	5.1%	78.7%	1.9%	1.9%	0.0%
Self-employed	10.6%	4.5%	21.3%	10.5%	3.3%	0.5%	8.5%	4.1%	3.2%	78.7%	6.0%	75.0%
Tertiary												
Unemployed	58.1%	5.8%	99.1%	10.8%	3.6%	0.0%	24.3%	5.0%	0.0%	6.8%	2.9%	0.9%
Public	0.0%	n.a.	6.7%	98.8%	1.2%	93.3%	1.2%	1.2%	0.0%	0.0%	n.a.	0.0%
Private	6.7%	2.5%	8.1%	2.9%	1.6%	0.0%	87.5%	3.3%	91.9%	2.9%	1.6%	0.0%
Self-employed	0.0%	n.a.	9.9%	6.1%	4.2%	1.6%	9.1%	5.1%	3.2%	84.8%	6.3%	85.4%

Table 18: 3-year labour market transition rates in Senegal

E   Appendix: Policy simulations

	Burkina					Senegal				
	Base-line	$2 \cdot v_g$	$0.67 \cdot c$	$\lambda = 0.5$	educ. policy	Base-line	$2 \cdot v_g$	$0.67 \cdot c$	$\lambda = 0.5$	educ. policy
Reservation productivity $R_p(y)$										
No education	15.2	12.4	18.4	27.0	14.9	20.2	25.6	19.6	54.3	20.2
Primary	15.9	14.0	19.1	20.6	15.6	12.0	10.1	16.5	38.7	12.0
Lower secondary	18.9	19.7	21.7	27.0	18.7	25.1	23.4	35.2	47.4	25.0
Higher secondary	20.8	29.5	20.7	24.8	21.4	24.9	20.8	37.1	56.6	24.8
Tertiary	63.1	53.1	89.6	97.6	61.7	61.6	69.2	72.1	113.2	61.6
Other parameters										
Offer rate: $q(\kappa)/\kappa$	0.19	0.19	0.25	0.18	0.19	0.14	0.14	0.19	0.13	0.14
LM tightness: κ	26.8	27.7	16.3	30.1	27.3	47.7	53.4	28.1	63.9	47.9
Formal vacancies: ϕ	0.31	0.00	0.54	0.13	0.28	0.56	0.05	0.72	0.30	0.55
Vacancy flow cost: c	973.5	973.5	652.2	973.5	973.5	2496.0	2496.0	1672.3	2496.0	2496.0
Public vacancies: v_g	0.59%	1.18%	0.59%	0.59%	0.59%	0.23%	0.46%	0.23%	0.23%	0.23%

Table 19: Results of policy simulations: Parameter values

	Burkina					Senegal				
	Baseline	$2\cdot v_g$	$0.67\cdot c$	$\lambda=0.5$	educ. policy	Baseline	$2\cdot v_g$	$0.67\cdot c$	$\lambda=0.5$	educ. policy
Overall sectoral allocation										
Unemployment rate	18.7%	19.9%	17.3%	15.0%	19.2%	18.8%	19.3%	17.5%	12.3%	20.1%
Share in public	20.6%	30.1%	14.7%	18.4%	30.0%	14.2%	29.2%	10.5%	12.9%	17.0%
Share in private	14.9%	0.0%	29.6%	5.1%	13.3%	19.4%	1.7%	29.9%	5.0%	22.2%
Share in self-employment	45.8%	50.0%	38.4%	61.5%	37.5%	47.6%	49.8%	42.1%	69.8%	40.7%
Share in unemployment (by education)										
No education	17.8%	20.0%	15.9%	12.0%	18.1%	15.5%	16.9%	14.4%	8.6%	15.5%
Primary	20.0%	20.5%	19.5%	16.5%	20.0%	21.1%	22.6%	19.4%	12.9%	21.1%
Lower secondary	23.2%	24.4%	21.4%	20.2%	23.4%	22.0%	21.2%	20.6%	16.2%	22.0%
Higher secondary	19.3%	20.3%	17.1%	18.7%	19.5%	22.1%	19.3%	20.8%	17.7%	22.1%
Tertiary	5.8%	5.2%	5.6%	5.0%	5.7%	11.6%	10.7%	10.8%	9.1%	11.6%
Share in public sector (by education)										
No education	4.8%	9.1%	2.8%	1.0%	4.9%	7.0%	14.7%	6.1%	4.0%	7.1%
Primary	10.3%	17.7%	7.4%	7.1%	11.0%	6.4%	15.7%	4.2%	4.8%	6.4%
Lower secondary	28.6%	40.8%	20.3%	25.6%	29.8%	20.3%	44.0%	15.6%	20.4%	20.6%
Higher secondary	50.7%	72.3%	37.0%	57.3%	53.3%	31.9%	60.1%	23.4%	28.9%	32.0%
Tertiary	63.1%	80.5%	47.0%	63.6%	64.9%	36.0%	64.4%	25.2%	38.9%	36.3%
Share in private-formal sector (by education)										
No education	15.0%	0.0%	28.7%	4.9%	12.9%	11.3%	0.8%	17.4%	4.0%	11.2%
Primary	14.8%	0.0%	28.6%	4.0%	13.5%	19.9%	2.7%	32.1%	5.4%	19.8%
Lower secondary	14.0%	0.0%	29.0%	6.0%	12.3%	24.1%	1.2%	35.3%	8.4%	23.8%
Higher secondary	16.5%	0.0%	34.4%	5.8%	14.6%	24.4%	1.3%	35.9%	8.0%	24.3%
Tertiary	15.8%	0.0%	32.8%	5.5%	14.1%	27.1%	1.9%	41.3%	8.0%	26.8%
Share in self-employment (by education)										
No education	62.4%	70.9%	52.4%	82.1%	64.1%	66.2%	67.6%	62.1%	87.3%	66.2%
Primary	54.9%	61.8%	44.5%	72.4%	55.5%	52.6%	59.0%	44.3%	76.9%	52.7%
Lower secondary	34.2%	34.8%	29.3%	48.2%	34.5%	33.6%	33.6%	28.5%	55.0%	33.6%
Higher secondary	13.5%	7.4%	11.5%	18.2%	12.6%	21.6%	19.3%	19.9%	45.4%	21.6%
Tertiary	15.3%	14.3%	14.3%	25.9%	15.3%	25.3%	23.0%	22.7%	44.0%	25.3%

Table 20: Results of policy simulations: Sectoral allocation

F Appendix: Media sources

On (public) employment creation:

- Niger: http://atelier.rfi.fr/profiles/blogs/niger-an-3-du-pr-sident-issoufou-les-bons-et-mauvais-points-du-3 accessed on October 19, 2017.

- Mali: http://malizine.com/2017/07/18/200-000-emplois-promis-president-ibk-taux-dexecution-chiffre-a-998 accessed on October 10, 2017.

On competition in selection procedures for public jobs:

- Burkina Faso: http://lefaso.net/spip.php?article78680 accessed on November 6, 2017

- Côte d'Ivoire: https://www.fonctionpublique.gouv.ci/?fp=nomenclature_concour accessed on November 6, 2017.

- Senegal: http://www.lejecos.com/Insertion-des-diplomes-Resorption-du-chomage-des-jeunes-Entre-lueurs-d-espoirs-et-issues-incertaines_a339.html accessed on November 6, 2017.

On supporting self-employment:

- Benin: http://anpe.bj/index.php?option=com_content&view=article&id=80:projet-emploi-des-jeunes-8-500-jeunes-selectionnes-pour-sortir-du-chomage-et-du-sous-emploi-2&catid=12:actualites-de-l-anpe&Itemid=128 accessed on October 19, 2017.

- Côte d'Ivoire: http://scaed.ci/content/emploi-des-jeunes-des-pr%C3%AAts-de-100-000-%C3%A0-700-000-f-cfa-aux-jeunes-de-10-r%C3%A9gions-pour-monter accessed on October 19, 2017.